GEAR OF THE YEAR
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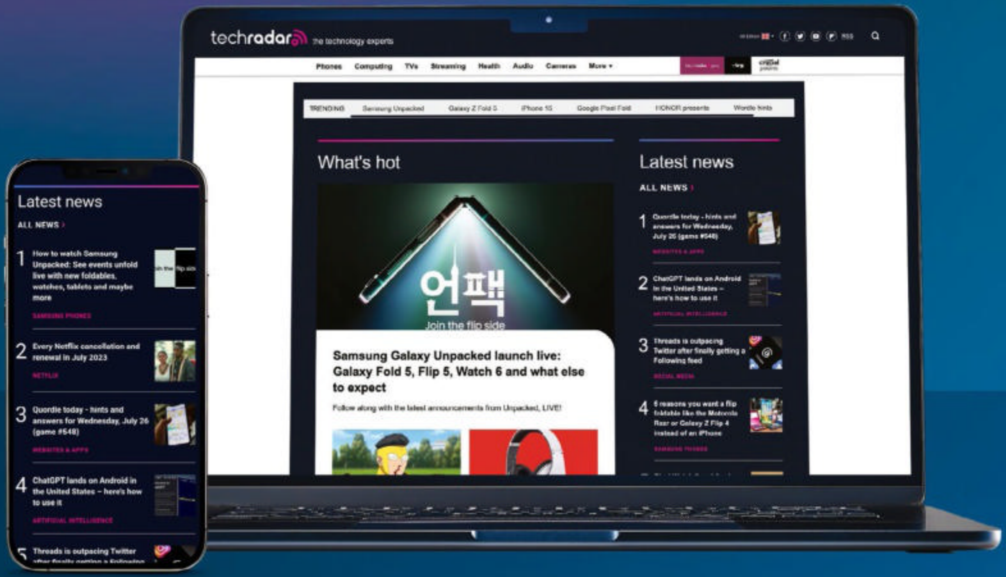
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Staff Writer: Sam Lewis
Contributing Writers: Alex Blake, Tim Danton, Shane Downing, Ian Evenden, Dave James, Jorge Jimenez, Jeremy Laird, Chris Lloyd, Nick Peers, Nik Rawlinson, Jacob Ridley, Zak Storey, Robin Valentine, Jarred Walton
Production Editor: Steve Wright
Editor Emeritus: Andrew Sanchez

ART
Art Editor: Fraser McDermott
Photography: Neil Godwin, Olly Curtis, Phil Barker
Cover Photo Credits: Microsoft, Asus, Future PLC

BUSINESS
US Marketing & Strategic Partnerships: Stacy Gaines, stacy.gaines@futurenet.com
US Chief Revenue Officer: Mike Peralta, mike.peralta@futurenet.com
East Coast Account Director: Brandie Rushing, brandie.rushing@futurenet.com
East Coast Account Director: Michael Plump, michael.plump@futurenet.com
East Coast Account Director: Victoria Sanders, victoria.sanders@futurenet.com
East Coast Account Director: Melissa Planty, melissa.planty@futurenet.com
East Coast Account Director: Elizabeth Fleischman, elizabeth.fleischman@futurenet.com
West Coast Account Director: Austin Park, austin.park@futurenet.com
West Coast Account Director: Jack McAuliffe, jack.mcauliffe@futurenet.com
Director, Client Services: Tracy Lam, tracy.lam@futurenet.com

MANAGEMENT
CEO: Jon Steinberg
MD Tech: Paul Newman
Group Editor-in-Chief: Graham Barlow
Group Art Director: Warren Brown

PRODUCTION
Head of Production: Mark Constance
Senior Production Manager: Matthew Eglinton
Production Manager: Vivienne Calvert
Production Assistant: Emily Wood

Future US LLC, 130 West 42nd Street,
7th Floor, New York. NY 10036. USA. www.futureus.com

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EXTRA DIGITAL FEATURES

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Guy
Cocker

INTEL'S 14TH AMENDMENT

IT'S FAST BECOMING *Maximum PC* Holiday issue tradition to go all-out with our cover build and put together the fastest machine possible. Perhaps it feels in keeping with the excess of the Holidays, or the fact that we're more inclined to let the purse strings go, or we feel the need to reward ourselves.

Of course, it's actually more to do with the fact that this is the time of year when Intel tends to release its latest top-end consumer CPUs, which we're more than happy to pair with the other vanguard PC components of the day. This year, that's the 14th generation Meteor Lake processor line, topped off by the $589 Core i9-14900K, which is the star of our cover build on page 16, and our lead review on page 74.

As you'll see from our review, Intel's annual release schedule is showing signs of strain. Sure, we're used to seeing the 'tick-tock' format of releases, with one major upgrade on the tick, and a more iterative one on the tock, but this year it is difficult to call these updates evolutionary, let alone revolutionary. That's not to say the i9-14900K is a bad chip, but when the conclusion of our review is that if you see the previous-gen 13900K and can save $30 or more by buying that then you should, it's hard to get excited.

Outside of our labs and in the real world, though, there are plenty of advantages to this slower pace of technological advancement. For example, these 14th gen chips support Z690 motherboards and DDR4 RAM, so you could save yourself a lot of money if you already own those components. You may, for example, be the owner of a 12900K, in which case you can swap out the CPUs and see significant performance gains—no more upgrades or fiddly component swaps required.

While the chip in this build isn't the most exciting thing of the year, what was exciting was inviting previous *Maximum PC* editor Zak Storey back for this build. You can catch Zak and I discussing the Story of the Build in our video feature on page 16, but as someone who's done over 100 builds, it was great to soak up some of his knowledge. Zak will also be back doing a build next month, when he'll be building a Core i5-14600K machine. At $319 and a likely 'best gaming CPU' contender, I can't wait to see how it performs.

As it's the Holiday issue, we also have our annual Gear of the Year special. When I put together the list of high-scoring products this year, I was astonished at how many more 8s, 9s, and 9 Kick-Asses we'd awarded this year. You can check out our favorite PC products from 2023 in our 16-page bumper feature, starting on page 32.

There are loads more things in the issue to get excited about beyond new Intel chips and Gear of the Year. We review our first PCIe 5.0 SSD on page 78, and check in with what's new in Windows 11's latest 23H2 release, including those much-vaunted AI-powered Copilot features (Goodbye, Cortana!). We also show you how to self-host your photos and videos and access them anywhere, rather than relying on a service you either have to pay for or has restrictions.

Have a wonderful holiday with your loved ones (by which I obviously mean your PC), and see you next year when we go on sale on January 2, 2024!

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's *editor-in-chief. He built his first gaming PC in 1997 to play* Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

Biggest model wins?

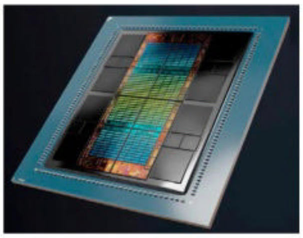
The AI arms race intensifies

THE RACE to have AI is over. Every big tech company now has an AI department, and is busy adding AI software and hardware to nearly everything in its portfolio. The race has now turned to building those large-scale models into *really* large-scale ones. The thinking is that the winners will be the ones with the biggest models: a lot of expensive hardware is currently being screwed together in server farms, and massive data sets collated.

The biggest AI application by far is OpenAI's ChatGPT, and it's estimated that 92 percent of Fortune 500 companies use it. Apparently, it boasts over 2 million developers. A new version is under testing, GPT-4 Turbo, which uses a new, larger data set, and can accept 300 pages worth of text prompt. Amazon is developing a system comparable with ChatGPT, called Olympus, but with double the parameters. The more parameters (variables) you have, the better the output. Meanwhile, Apple is reportedly about to invest $1 billion in getting AI into its products. Microsoft poured $10 billion into OpenAI early this year. Elon Musk has a new chatbot too, called Grok. Apparently it will have a humorous and sarcastic edge, and is partly inspired by *The Hitchhiker's Guide to the Galaxy* (brilliant, but it doesn't always end well for AI). Grok uses X's data, so can react quickly to current events.

This is good news if you make AI silicon. Nvidia is the king of the hill here. Its new Eos supercomputer is three times faster than its best system of just six months ago, and 73 times faster than systems from 2020. It has also launched the H200 chip, which nearly doubles performance. Meanwhile, AMD's new AI chip, the M1300, is ready to ship. It carries a CPU, GPU, and memory on one chip, and has 146 billion transistors—a third more than Intel's most complex data center silicon.

IBM has revealed its NorthPole chip architecture, designed for high-efficiency AI work, which has been eight years in development. Meanwhile, we are rapidly approaching Intel's Meteor Lake launch, which includes an AI tile. The event is to be branded 'AI everywhere'. Intel plans to have 100 million AI-capable PCs shipped by 2025. These can run small AI applications locally, including gaming, video, audio, security, content creation enhancements, and more.



The new M1300 chip is aimed at generative AI—exactly what everybody wants now.

Not everybody is enthusiastic about AI's development. Its ability to predict our opinions is perhaps one of the more chilling applications. We consider ourselves individuals, but seen as a group, we aren't. AI can identify our characteristics, categorize them, and be used to push us one way or the other. This cognitive manipulation sounds dystopian, but it's real, and works. Mass surveillance is another worry. There are over a billion cameras watching us in the world, 626 million of which are in China—close to one for every two citizens. Linked to AI-powered image recognition systems, it's hard not to be noticed. The ramifications for cyber security are alarming, too.

Currently, there are no solid regulations specifically aimed at AI applications. Its uses are being left to big tech and the market. This is going to change. The White House has just announced a new order to temper AI's effects: the Executive Order on the Safe, Secure, and Trustworthy Development and Use of Artificial Intelligence. It is to cover transparency, safety, testing, data collection, discrimination, research, and more, with new rules and responsibilities. It's comprehensive, but as ever, the law is a slow-moving thing.

The European Union also proposed regulations in April 2021. It holds social engineering, social scoring, and remote bio-metric identification as three 'unacceptable risks', along with eight other areas of 'high risk'. The first international summit on AI safety took place in November, prompted by concerns expressed by governments and international organizations. It is due to meet again next summer, and could be the start of a permanent international body.

The AI genie is out of the bottle. The next generation, the Frontier Model, will be more powerful still. As with any disruptive technology, controlling the collateral damage can't be ignored. Sound gloomy? AI can do wonderful things, such as identifying possible cures for cancer, doing in a weekend what would previously have taken months or years of research. There will be a boatload of amazing and fun things along soon. Wait until it has an impact on gaming. **–CL**

> “
> Intel plans to have 100 million AI-capable PCs shipped by 2025

© AMD

NEW OVERCLOCKING RECORD BROKEN

INTEL® CORE™ i9
i9-13900K
SRL4H
V1341690

ASUS GOT HOLD OF the new Intel flagship processor, the Core i9-14900KF, and bathed it in a flow of liquid helium to see how far it could be pushed. After a week, they found out: 9.044GHz on one core. This broke Asus' record by 35.1Hz, achieved with the i9-13900K. Helium is the only material that stays liquid at absolute zero under normal pressures. It boils away almost immediately, so you have to continuously apply it. While not reproducible at home, it shows how stable the new chip is.

Meanwhile, Intel has an as yet unannounced new processor: the i9-14900KS, with a boost clock of 6.2GHz. It is expected to be rated with a TDP of 150W, and a peak power draw of 320W. Objectively that is just a 3.33 per cent gain over the i9-14900K, but what you are buying here is a carefully binned chip, and the best candidate for overclocking. If previous pricing models are retained, it'll cost $699. Expect it to feature in a new round of benchmark records soon. **–CL**

RTX 4000 GOES SUPER

IT IS PRETTY MUCH an open secret—Nvidia is preparing to launch three 'Super' versions of the 4000-series: the RTX 4080, 4070 Ti, and 4070. This will plug some gaps in the 4000-series range, and address the pricing bands. The branding is odd, as Nvidia has used either 'Ti' or 'Super' as indicators of upgraded versions. Here, it will use both on the RTX 4070 Ti Super, as leaked box art shows. Rumors of a 20GB 4080 Super appear misguided—it'll sport a full AD103 GPU, so gains 512 cores. The 4070 Ti Super gets an AD103 chip too, and more VRAM at 16GB, while the 4070 Super gets an extra 1,280 cores—enough of an upgrade to warrant a 20W increase in power requirements. Pricing will be key, as Nvidia has made a mess previously, losing middle ground to AMD cards. These cards are a chance to redress that. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **SCROLL DECIPHERED**
Researchers have managed to read a word of the burnt scrolls of Herculaneum, using X-rays, a particle accelerator, and AI.

✓ **ROBOT EMPLOYEES**
Amazon has created humanoid robots. At 5' 9'', they can carry up to 35lb for up to three hours.

✓ **STAR TREK AI PIN**
A start-up is set to launch its wearable device that uses AI to predict your needs. Yours for $699.

TRAGEDIES

✗ **DISK FAILS EXPLAINED**
The failure of SanDisk SSDs has been discovered to be poor manufacturing, rather than a firmware problem.

✗ **EXPENSIVE MEMORY**
The new M3-powered MacBook Pro comes with 8GB, and costs a minimum of $1,599.

✗ **NO SENSE OF PROPORTION**
Cities: Skylines 2 runs horribly slowly, because it renders everything in massive detail, even if it's far away or hidden.

STEAM DECK OLED

Major update to Valve's gaming handheld

VALVE'S STEAM DECK has received an overhaul. Obviously the screen changes from LCD to OLED, but there's much more than just that, as almost every part has been redesigned. The upgrade is not focused on raw performance—more a better version of the original. This means the processor specification remains the same, as does memory and storage. The list of changes, however, is huge, as almost no components have been carried over.

The HDR screen is 7.4-inch, 90Hz, and 1,000-nits. That's a big upgrade over the old LCD, which was a 7-inch, 60Hz, 400-nit unit. The new screen has a considerable expanded color gamut, too. Battery life is said to be 50 percent better, thanks to better efficiency and a 20 percent size increase. The AMD silicon is now on a 6nm process rather than a 7nm one. Memory speed has bumped from 5500MT/s to 6400MT/s. Other improvements include Wi-Fi 6E, a quieter fan, higher fidelity haptics, faster touchscreen polling, redesigned bumper switches and thumbsticks, faster charging, better sound, and more. It even manages to be over an ounce lighter.

The result is a machine that is better than the original in almost every metric. Games run better (not significantly quicker though), download faster, are more stable, look brighter and clearer, and play for longer, while the machine stays cooler and quieter. Initial reviews have been glowing. The screen looks much better, with deep blacks and vibrant colors. Not increasing the raw power is a confident move, meaning the Steam Deck can still struggle with more demanding AAA games, so don't expect Starfield to run effortlessly.

The new Deck is $549 for the 512GB version or $649 for 1TB, with a limited edition 1TB transparent case version at $679. The LCD version will live on, but only as the $399 256GB base version, with both the 64GB and 512GB ones discontinued. Valve calls this the definitive version of the first generation of the Steam Deck. **–CL**

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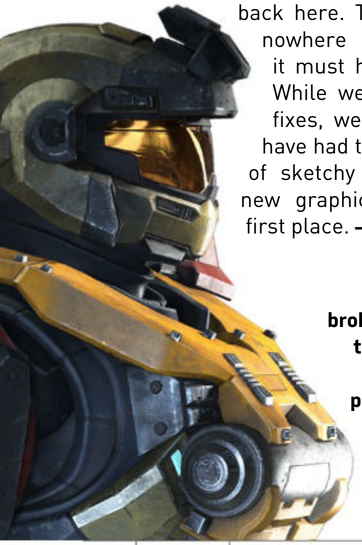
ARC DRIVERS ADDRESS DX11

Halo plays properly now

INTEL'S FORAY into discrete graphics cards has been a mixed bag. It started at the bottom of the market, and had, frankly, appalling drivers. The hardware has reached mid-range, but has always been hampered by driver problems. Alchemist was designed for DX12 gaming, but that's not every game, especially if you're sporting lower-level hardware. Performance on DX11 games was a mixed bag, from adequate to a disaster. Important DX9 games such as *Counter-Strike* were effectively broken on the original drivers, too. Intel has been working to remedy this, publicly admitting the problem, and its intent to fix it as a "labor of love".

The latest driver, (31.0.101.4952) is geared at a selection of DX11 games, and Intel has some claims for performance increases on a raft of top-tier DX11 games. One that stands out is for *Halo: The Master Chief Collection*, The claim is for an average of a 750 percent increase in FPS at 1080p with enhanced settings. Other gains are less dramatic, but still significant. *Yakuza 0* gains 154 percent, *World War Z* gains 113 percent, *Guild Wars 2* gains 53 percent, *Sniper Elite 3* gains 37 percent, and another nine top titles gain from 6 to 27 percent. A couple of DX12 games get a boost too. It also adds 'support' (effectively meaning it should run properly) for *Call of Duty: Modern Warfare III*, and four other new games.

There is some truth to the adage that drivers aren't perfected before the hardware is obsolete. However, in its rush to release the hardware, Intel has made a rod for its own back here. The drivers were nowhere near ready, and it must have known that. While we welcome these fixes, we really shouldn't have had to endure months of sketchy support on our new graphics cards in the first place. **–CL**



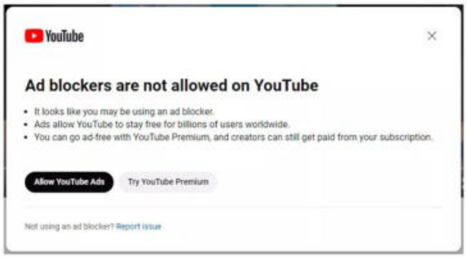
From decidedly broken to playable on the Arc Alchemist: *Halo* gets a 750 percent frame rate boost with the latest drivers.

YouTube blocks ad blockers

AD BLOCKERS ARE EVERYWHERE. An estimated 37 percent of internet users run them—among the more technically savvy it'll be more than that. Some haven't seen the internet without a blocker for years, which makes seeing it in all its ad-festooned glory a shock. Blocking ads blocks potential revenue, so it's not popular with tech firms, especially Google, who gets about 80 percent of its revenue from them. YouTube has been experimenting with banning ad blockers, and now it's gone global, claiming ad blockers violate its terms of service. A pop-up asks you to turn ad blocking off, or pay for a premium service. Otherwise, there's no more (relatively) ad-free YouTube. Needless to say, this has not been popular. It is a staple service for many, and been viewed as free for years. YouTube Premium is $13.99 a month, or $139.99 for a year.

There is one easy fix: sign out of YouTube. It's probably not a bad thing to do occasionally anyway, as the platform can become an echo chamber. One Irish user, however, has decided to follow the legal route. The privacy consultant is challenging YouTube's right to run scripts to detect ad blockers, which he claims are effectively spyware. Under EU law, consent has to be given for tracking—similarly under separate Irish law. Don't hold your breath though, as these proceedings can take years.

The move has reportedly led to significant levels of uninstallations for ad blocking software, and the search for a block to the block. One company in Slovakia that produces AdLock claims it has already managed to get around Google's restrictions. Reportedly, uBlock Origin also appears to work for many. The move has triggered a race between Google and the ad blocker developers. Facebook faced a similar confrontation in 2016, quietly conceding. It'll be interesting to see if Google can get this one to stick. **–CL**



Ad blockers are not allowed on YouTube

- It looks like you may be using an ad blocker.
- Ads allow YouTube to stay free for billions of users worldwide.
- You can go ad-free with YouTube Premium, and creators can still get paid from your subscription.

Not using an ad blocker? Report issue

YouTube wants you to watch adverts, or pay for a premium service from now on. Boo.

Windows update adds Copilot

The latest Windows update, 23H2, has added Copilot to Win11. It saw a limited roll-out a few weeks ago, now it is baked into the OS. Copilot is available from the taskbar, or by keyboard shortcut (Windows key + C and replacing Cortana, which is now dead). As with ChatGPT, you can use text or voice prompts to create generative text replies or issue voice commands. Satya Nadella, Microsoft's CEO, claims Copilot will be central to Windows, effectively becoming the new Start button. Instead of starting with an application, you'll choose Copilot, and it will steer from there. 23H2 also brings a overhaul of File Explorer, a cloud back-up tool, upgraded Paint, and a few interface tweaks, including new 'classic' features for when previous features weren't as welcome as Microsoft thought. **–CL**

New Threadripper beast

AMD has revealed its Zen 4-based Threadripper processors, with up to 96 cores and 192 threads. Early tests of the Threadripper Pro 7995WX show them to be the proper monsters you might expect: it trounced comparable Intel systems, and is over 50 percent faster than the previous generation's 5995WX. The 'WX' Threadrippers are aimed at Workstations, but if you fancy a piece of the action then AMD has three 'X' Threadrippers: the $4,999 7980X, which carries 64 Zen 4 cores; the $2,499 7970X with 32, and the £1,499 7960X with 24. You'll also need the new TRX50 motherboard, with 88 usable PCIe 5.0 lanes, and quad-channel memory support. The result will be a beast. AMD's return probably won't revive the HEDT markey, but it gives ambitious builders something to think about. **–CL**

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Jarred Walton

TECH TALK

AMD's FreeSync Standard Quietly Won the VRR War

VARIABLE REFRESH RATE (VRR) displays were a hot topic when Nvidia revealed G-Sync in 2013. Tying monitor refreshes to the availability of new data from the GPU didn't immediately catch on, in part because G-Sync required a new monitor and an Nvidia GPU. AMD announced its FreeSync standard in 2014, with the first solutions appearing in March 2015.

Eight years later, there's little doubt about which technology won out. G-Sync still exists, but the number of new 'true' G-Sync displays—as opposed to G-Sync Compatible options—has dwindled to almost nothing. For example, Nvidia lists just 23 G-Sync Ultimate monitors. Those are supposedly the best displays Nvidia and its partners offer, and most of these are several years out of date. If you want a 4K monitor, there are only ten G-Sync Ultimate options, compared to 79 G-Sync Compatible Solutions, all with a maximum refresh rate of at least 120Hz.

I've used G-Sync displays for most of the past eight years, and they've been mostly fine—for Nvidia GPUs. On AMD and now Intel GPUs, those same displays only work as fixed refresh rate solutions. Even worse was the Acer X27 G-Sync Ultimate display. The display looked great, but the fan that's required to keep the FPGA G-Sync module cool died after just over a year. It's been limping along with a USB-powered replacement, because why would I spend $80 for a new heatsink and fan that are identical to the original solution that failed so quickly?

In the meantime, AMD and the Adaptive Sync consortium have moved along, and just about every new monitor now ships with FreeSync/Adaptive Sync support. The scalers are also far lower power than the FPGA Nvidia's upgraded G-Sync displays had to use, which means fans aren't normally required. Not all these displays work properly with VRR enabled, however, and it's ironically Nvidia's G-Sync Compatible program that often helps sift through the cruft. Pick a display that's G-Sync Compatible, and you'll know Nvidia has tested it to work with its GPUs, so it will likely also work with AMD GPUs.

The Samsung Odyssey Neo G8 32-inch monitor is one of the best around

© SAMSUNG

This is all we wanted: someone to test monitors and ensure they function as intended. That should have been VESA, but it was a bit late to the party. There's now a VESA VRR certification (as of 2022) that sits alongside the AMD and Nvidia certs, which is supposed to indicate that a monitor passed the required Adaptive Sync tests. While the original VRR solutions were only for DisplayPort connections, HDMI 2.0b and later became a bit of a wild west, making it difficult to know for sure whether VRR would work properly or not.

The good news is things are settling down. Nvidia has taken its foot of the display connectivity gas pedal, topping out at HDMI 2.1 (42 Gbps data) and DisplayPort 1.4a (25.6 Gbps data), while AMD is shipping DisplayPort 2.1 compliant GPUs with up to 52.2 Gbps of data bandwidth. Monitors with DP2.1 are available, but even DP1.4a can drive up to 4K at 240Hz using Display Stream Compression. That's what Samsung's Odyssey Neo G8 line uses, and it works on AMD and Nvidia GPUs, with either HDMI or DisplayPort.

Sometimes, choice is good, but when it comes to standards, proprietary solutions don't normally stand the test of time. It's unfortunate that we have a bunch of monitors that mostly had to opt for being either G-Sync or FreeSync, but moving forward, we should hopefully end up with options that work with both AMD and Nvidia VRR technology. Now, what's the chance of that happening for ray tracing solutions?

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

THE LIST

THE BEST HANDHELD GAMING PC IN 2023

UNTIL VERY RECENTLY, the handheld gaming PC market was essentially just the Steam Deck, with not enough contenders to round out a Top 5 list. However, over the last six months, rarely an issue has passed where we've not had one feature in our reviews section. The ability to play your favorite PC games wherever you are clearly appeals to a lot of buyers, but how do you make sure you get the best bang for your buck? By buying one of our picks below, of course.

5

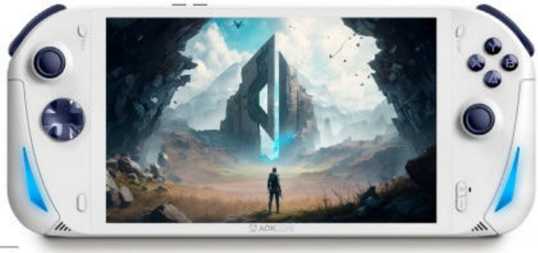
AYANEO AIR 1S

Go for the Ayaneo Air 1S because it's incredibly portable, coming in at just 21.6mm thick and weighing only 450g. You needn't worry about its inclusion in your luggage if you're traveling long distances. Its size isn't at the cost of power, thanks to the beefy AMD Ryzen 7 7840U chip found in the other top-end models on this list. **www.ayaneo.com, $799-$1,179 (depending on configuration)**

4

AOKZOE A1 PRO

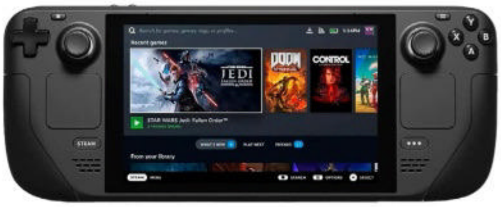
The killer feature on this gaming handheld? That 8-inch 1,920 x 1,200 display that makes PC games that would be otherwise barely playable on a small screen eminently enjoyable. The downside is that it isn't cheap, and pushes the product into gaming laptop-level prices. If money's no object though, the A1 Pro is the one on this list we find ourselves coming back to the most. **www.aokzoestore.com, $999-$1,359 (depending on configuration)**



3

STEAM DECK

With the new Steam Deck OLED landing, the older LCD model has received a discount. If you bear in mind that the Switch costs $300, the Steam Deck looks like a bargain. The processor lags behind the others on this list, but it'll play most AAA games. **www.steampowered.com, $349 (64GB)**



2

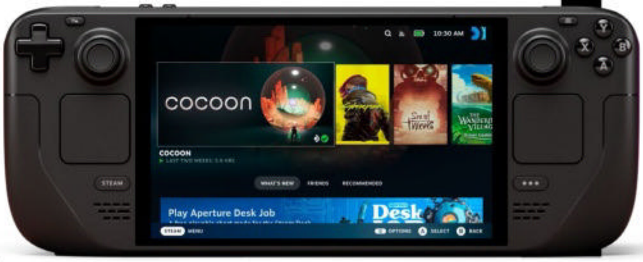
ONEXPLAYER ONEXFLY

The most well rounded option of the bunch, thanks to a lighter and smaller body. AMD's latest 7840U APU has a lovely 120Hz display, great longevity thanks to a 48Wh battery and power management options, and fast LPDDR5X-7500 memory. It's a sleek all-rounder. **onexplayerstore.com, $739-$1,299 (depending on configuration)**

1

STEAM DECK OLED

In with a bullet even before we've properly reviewed it is Valve's first revision to its handheld gaming PC. It's not be the most powerful model, so don't expect to be able to crank up the settings on newer games like *Starfield*, but this is still the best option for most, thanks to its keen price, ease of use, and that stunning OLED screen. It's the best portable console screen ever made. **www.steampowered.com, $549 (512GB), $649 (1TB)**



© AYANEO, AOKZOE, STEAM DECK, ONEXPLAYER

Jeremy Laird

TRADE CHAT

Arm's time finally come on the PC

ARM VERSUS X86 is a battle for the ages, but the idea of PCs powered by Arm processors is a notion that's always just over the horizon. Just as commercially viable nuclear fusion is always 30 years away, Arm's assimilation looms large, but never happens—until now. In the last few months, it's become clear that Arm might be ready to take over the PC.

The tipping point, when we look back years from now from our brain-embedded Arm PCs, will likely be 2024. That's the year that Qualcomm's exclusive deal with Microsoft to provide chips with the Arm-compatible version of Windows expires and we see just what the market is capable of.

Qualcomm will be first out of the gate with a CPU for Windows on Arm. After years of lazy chip designs using off-the-shelf cores provided by Arm itself, Qualcomm has cooked up a radical new processor with cores designed in-house.

Strictly speaking, the Oryon cores inside Qualcomm's new Snapdragon X Elite chip were designed by a startup known as Nuvia, populated by the same ex-Apple engineers who helped make its silicon the most powerful Arm-based hardware you can buy in consumer computing devices today.

Qualcomm bought Nuvia in 2021, and the recent unveiling of the Snapdragon X Elite was the culmination of this. It's not clear when the first devices with the chip will appear, but we know it's designed to be a high-performance CPU for laptop PCs, and that Qualcomm is making big claims.

First, Qualcomm claims it offers over 10 percent better single-thread performance than any Apple M2 chip, on par with or possibly just behind Apple's new M3 silicon. At the same time, Qualcomm says it can match M2's single-thread performance on 30 percent less power. As for the x86, Qualcomm reckons Snapdragon X Elite has the edge on Intel's top Core i9-13980HX CPU for single-threaded performance, and can match it while consuming 70 percent less power.

Snapdragon

Qualcomm's new Snapdragon X Elite looks like a genuine x86 killer.

> Qualcomm claims that it offers over 10 percent better single-thread performance than any Apple M2 chip

The multi-thread comparison is more complicated, given that there are x86 and Apple chips with numerous core counts. But with 12 cores, each claimed to have industry-leading performance, the Snapdragon X Elite will be no slouch. Next year, you'll be able to choose between the x86, Apple MacBooks, and a new generation of Qualcomm Snapdragon X Elite-powered laptops.

Thanks to the expiration of Qualcomm's exclusive Windows deal, you will see further options in the Arm-powered laptop PC market. Both AMD and Nvidia are working on their own Arm processors for Windows PCs.

At the same time, Microsoft has improved the emulation layer in Windows for Arm, which allows legacy x86 software to run on these new chips. Six months from now, you could buy an Arm-powered Windows laptop that runs the majority of existing Windows code as well as a native x86 machine.

But why not just run an actual x86 laptop? If you've used a MacBook with Apple silicon, you'll know it trounces any x86 platform for efficiency. Also, you'll get more bang for your buck.

The application that Arm platforms will find hardest to crack is gaming. Even the slightest deficiency in emulation will be obvious when it comes to in-game frame rates. It's a big ask for developers to compile and optimize games for both x86 and Arm.

The final piece of this puzzle is the recent tranche of leaked documents from Microsoft revealing that Arm CPU cores are being considered for the next-generation Xbox console. If that happens, x86 chips in consumer PCs could be on borrowed time.

Six raw 4K panels for breakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

© QUALCOMM

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Which OC tool?
> Self-hosted chat
> Fix botched cleanup

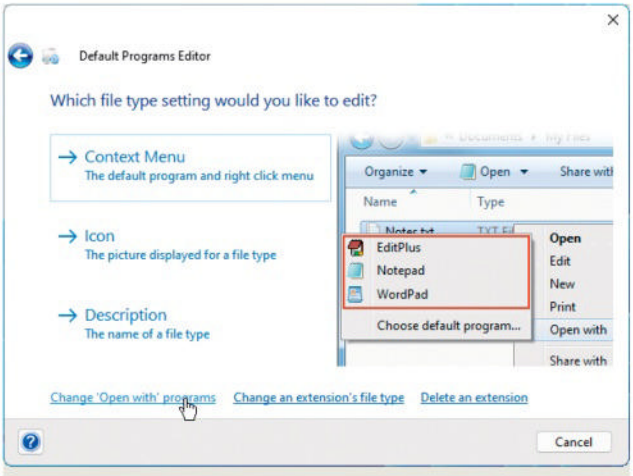
Overclocking conflict

I reinstalled my old RX 570 graphics card in a rig for my brother, and wanted to give him a free speed boost as an extra present. While I can overclock the memory to 1,750 MHz with MSI Afterburner, if I install AMD's Adrenaline on to the system, it'll crash—black screen, followed by the PC freezing. However, if I raise the voltage controller memory setting in Adrenaline before applying the change in Afterburner, it works okay. Why is it doing this? No voltage settings are required when it's just MSI Afterburner installed.

—Phil Strader

THE DOCTOR RESPONDS: This sounds like a classic software conflict where one application (Adrenaline) overwrites the changes of another (Afterburner), resulting in the problems you've experienced. Ultimately, Adrenaline is optimized for AMD cards, so there's no reason to use Afterburner—instead, remove it and overclock using Adrenaline to see if you can achieve the same results without Afterburner.

If you go down this route, you may want to experiment with some other tools that don't conflict with Adrenaline—Fan Control (https://getfancontrol.com) does a better job with custom fan curves for keeping your card (and the rest of your system) cooled, while HWiNFO64 (www.hwinfo.com) can monitor and identify which fan is which for Fan Control's benefit.



Which file type setting would you like to edit?

Default Programs Editor
Context Menu
The default program and right click menu
Icon
The picture displayed for a file type
Description
The name of a file type
Organize
Open
Share with
Name
Type
EditPlus
Notepad
WordPad
Choose default program...
Open
Edit
New
Print
Open with
Share with
Change 'Open with' programs
Change an extension's file type
Delete an extension
Cancel

This freeware tool makes editing default apps easy.

Secure messaging

I'm on the hunt for a secure way to chat with friends and family—something that isn't likely to fall foul of law enforcement or requires any kind of personal identification to set up—which is why I ruled out Signal, because it requires a mobile phone. Can you suggest a suitable setup?

—Damien Williams

THE DOCTOR RESPONDS: The biggest hurdle in any switch to a more secure messaging platform is buy-in from your contacts. The Doc has found himself spread across multiple platforms, preferring Signal for its privacy, but forced to compromise to stay in contact, so he hopes you're able to sell the solution you choose to your wider circle.

Ultimately, we're going to recommend a self-hosted solution, which you'd install on your own server and open to the internet through a dynamic domain or subdomain. Self-hosted doesn't necessarily mean more secure, but it does reduce the attack vector by making you less visible than when using a public messaging platform. Any self-hosted service with access through a domain is publicly visible, so make sure you keep it secure—use Docker/Podman where possible, as the service can at least be isolated inside its own container.

Self-hosted chat services aren't rare, but for personal use, you don't want to pay for the privilege. One interesting example that's not quite ready for prime time, but looks to offer your contacts a user-friendly, slick experience, is Snikket (https://snikket.org). The server can be deployed through Docker or Podman, then each friend or family member connects to it through their own Snikket mobile app. The issue here is that while the Android version is available through the Google Play store, you'll need to install TestFlight to beta-test the app on iPhone or iPad. There's also no desktop or browser-based

© MICROSOFT

↘ submit your questions to: doctor@maximumpc.com client, although both are in the pipeline.

Another option is to examine our 'Build your own cloud storage' feature back in the October 2023 issue. Our chosen platform—Nextcloud Hub—comes with built-in chat capabilities in the form of Nextcloud Talk, which allows you to connect to anyone with accounts set up on your specific Nextcloud instance, but no one else, which obviously helps block eavesdroppers. Your friends and family can connect through dedicated Nextcloud Talk apps for iOS and Android, or through their web browser. Find out more at https://nextcloud.com/talk, and if you go down this route, we strongly advise you enforce 2FA on any Nextcloud accounts you create to boost security.

Broken app associations

I had to move my portable applications folder to another drive, but not only have I broken a file association (.7z files), the now-redundant program entry (7-Zip Portable) remains an option in the 'Open with' menu. If the broken shortcut icon wasn't a giveaway, choosing this option has no effect, returning me to the 'Open with' menu. How do I remove these links or update them to point to the app's new location? **—Mayra Kea**

THE DOCTOR RESPONDS: You'll find these entries in the Registry, Mayra, but thankfully there's a free tool that can repair the file association. Download Default Programs Editor from https://defaultprogramseditor.com. The utility is portable too, so simply extract its contents from the zip file and double-click Default Programs Editor.exe to get started.

Select 'File Type Settings', followed by 'Context Menu'. Select .7z from the list and click Next. With Open selected, click 'Edit Selected Command…', then click Browse to locate and select the 7-ZipPortable.exe program file from its new location. Click Browse next to 'Item icon', and you can re-select the app icon. Click Next, followed by Save Context Menu > OK > Close.

That fixes the primary problem when double-clicking the file, but you may find that the orphan entry remains alongside it under the 'Open With' menu. This is a problem specific to .7z files—the solution lies in opening Registry Editor and navigating to Computer\HKEY_CLASSES_ROOT\7z_auto_file\shell\open\command, where you'll find a value pointing to 7-Zip's old location. Delete the 7z_auto_file key, close Registry Editor, and then restart Windows Explorer (right-click the taskbar and choose Task Manager, then select the Windows Explorer entry before clicking 'Restart task'). The obsolete entry should be removed, leaving your now-working shortcut to as the only option for opening 7-Zip Portable.

Stop laptop dimming

My new laptop screen is a real pain—it must be set to adaptive dimming like my phone, as it's constantly increasing or decreasing the brightness depending on the light conditions to make it difficult to read. I'd like to control this manually—is there any way to do so?

—Arthur Frisina

THE DOCTOR RESPONDS: Open Settings and navigate to System > Display. Select Brightness and click the 'Help improve battery by optimizing the content shown and brightness' dropdown to either switch adaptive brightness off completely or simply restrict its use to battery power.

Some desktop PCs have this feature—in this case, the option is usually marked 'Change brightness automatically when lighting changes'. If you can't find either feature, it's likely that adaptive brightness isn't supported; verify this by typing 'power' into the search box and clicking 'Edit power plan'. Click 'Change advanced power settings', expand 'Display > Turn off display after'. If there's no 'Enable adaptive brightness' setting, it's not supported.

Cleanup gone wrong

My Windows boot drive showed less than 5GB free space, so after a cleanup using BleachBit (freeing up 15GB), I decided to prune my installed apps, as I'd been trialing some software that was taking up gigabytes of space. Unfortunately, I used Bulk Crap Uninstaller's mass uninstall option, which led to Adobe Premiere Elements and Photoshop Elements' uninstallers complaining of not being able to work because of other uninstallers running. The result is a partially uninstalled program with no uninstaller entries. How do I fix this?

—Harold P Borel

THE DOCTOR RESPONDS: While it's tempting to simply delete the program folder or try some of BCU's manual removal tools, it's best to first try reinstalling the program over the top of itself.

When Harold came to try this, he received an error message telling him another uninstall process was running. We instructed him to open Device Manager, where he could see the presence of an Adobe Uninstaller process—right-clicking this and choosing 'End task' allowed the Photoshop Elements installer to run successfully. It detected a previous install (the partially removed version), and was able to install itself over the top.

Unfortunately, the installer failed to generate the required uninstaller entry in Windows or BCU, which left us with no option but to instruct Harold to open BCU and choose 'Tools > Uninstall by window, directory or file'. Click 'Link or application's file…' Browse to Program Files\Adobe\Photoshop Elements 2024 and select PhotoshopElementsEditor.exe. Click Open, then follow the same uninstall wizard—when the uninstall completes, perform the same step.

Once done, check the Program Files\Adobe folder for an Elements 2024 Organizer folder. Remove this in the same vein using BCU, this time targeting the file PhotoshopElementsOrganizer.exe.

Removing Docker Desktop

After reading your head-to-head on Podman over Docker, I've decided to switch. However, when I attempt to remove Docker Desktop from my Windows PC, it gets stuck at the 'Removing VM and Images' stage. I don't want to install Podman until Docker Desktop is gone—can you help?

—William Huskins

THE DOCTOR RESPONDS: Many people confronted by this problem have reported success by stopping the Docker Desktop Service prior to attempting removal—press Win + R, type services.msc and click OK. Locate the Docker Desktop Service entry, then right-click it and choose Stop. In William's case, the uninstaller moved on to hang at the next stage—deleting files—of the process. What finally worked was to open a Terminal window—right-click the Start button and choose Terminal (Admin)—and then issue the following command:

```
wsl --shutdown
```

This shuts down the Linux Subsystem engine Docker runs on, letting it complete the removal process.

THE ULTIMATE INTEL 14TH GEN GAMING PC

These aren't the CPUs you're looking for

Another year, another Intel CPU refresh, complete with all the fanfare, bells and whistles, and general hubbub we've come to expect from Team Blue over the last few generations. 14th gen has arrived, and with it, a fresh batch of already well-aired processors are now available for you to purchase.

At first glance, these new processors aren't quite as impressive as the PR furor suggests. Let's take the Intel Core i9-14900K as an example, and compare it to the last gen's 13900KS. It features the same core count, boost clock, cache, memory support, and a fairly similar TDP. The only comparable differences between the two come in the form of the E-Core clock speeds being slightly higher on the 14th gen (we're talking a couple of hundred MHz). Likewise, the base clock on the performance cores has been amped up by a similar amount. Yes, you could argue that there has been a marked price drop (the 13900KS retailed for $699 on launch versus the 14900K's $589), but aside from that, there's very little to differentiate the two, outside of a few software tweaks, namely Intel's Application Optimization tech (better known as APO—think smart resource thread scheduling).

With that in mind, we took Intel to task, and got hold of the latest flagship CPU, the Core i9-14900K, with one aim: to really put it to the *Maximum PC* test by doing what we do best, namely sticking it in a kick-ass build and seeing how that clock ticks.

So then, what exactly does this exciting new generation bring to the table? Is it worth spending your hard-earned cash, on yet another refresh from Intel? Or is it perhaps better instead to wait for the next iteration of CPU juggernauts from those titans of the processor manufacturing industry that we all know and love? Let's find out. **–ZAK STOREY**

INGREDIENTS

PART		PRICE
CPU	Intel Core i9-14900K	$598
Motherboard	Asus ROG Maximus Z790 Dark Hero	$700
CPU Cooler	NZXT Kraken X73 RGB 360mm AIO	$225
RAM	32GB (2x16GB) Corsair Vengeance DDR5 @ 4800	$100
SSD	1TB Adata Legend 960 Max M.2 PCIe 4.0 SSD	$70
GPU	Nvidia GeForce RTX 4090 Founders Edition	$1,600
Case	NZXT H9 Flow ATX Mid Tower Black	$160
PSU	1200W Corsair RMx Shift 80+ Gold	$230
Airflow Fans	3x Corsair LL120 White	$83
Static Pressure Fans	3x Corsair SP RGB Elite 120mm	$65
Fan Controller	Corsair Commander Core	$40
TOTAL		**$3,871**

PRICES CORRECT AT THE TIME OF PUBLICATION

https://content.jwplatform.com/videos/ukaVeghk-u2lN49He.mp4
Please type this URL into your browser if the link is broken

GEFORCE RTX
NZXT

HARDWARE SELECTIONS

GPU

NVIDIA GEFORCE RTX 4090 FOUNDERS EDITION

Love it or hate it, the RTX 4090 is still the king of GPUs. With 24GB of RAM, 76.3 billion transistors, and plenty of CUDA cores, it makes 4K gaming at 120 fps a stone-cold reality.

There are, of course, some caveats. First, you need a decent motherboard to support it (digitally and physically), and you have to consider the power supply situation. We'll come onto that in a bit with our PSU of choice for this build, but please bear in mind that this card has a 450W TDP (toned down from 600W prior to launch), and as such needs to be treated with respect.
$1,600, www.nvidia.com

CPU

INTEL CORE I9-14900K

This pivotal piece of the puzzle packs some potent performance buried deep within its refreshed Raptor Lake architecture. There are eight performance cores with hyper-threading, and 16 efficiency cores without. A 3.2 GHz base has a 6 GHz boost clock, and 68MB of L2 and L3 cache across the board.

Couple that with an overly impressive memory controller and an incredibly aggressive price, and you're left with a versatile processor that is more than capable of handling any game or heavily threaded workload task without breaking a sweat.
$598, www.intel.com

Motherboard

ASUS ROG MAXIMUS Z790 DARK HERO

With a great processor comes great responsibility—and that responsibility is simple enough. You need a motherboard capable of flooding the chip with a stable current, and one that packs in an incredible feature set to complement that behemoth as it does so. That's where the Z790 Dark Hero comes in from Asus. This is an absolute monster of a motherboard, and it needs to be for $700, because let's be clear, that's new graphics card-level money right there. We're long past the era of $300 mobos being considered 'premium', sadly.

Intel's 14th gen comes with some neat AI tricks up its sleeves when it comes to auto-overclocking, and with that comes a requirement for a) an epic cooling solution, and b) lots and lots of power. The Z790 Dark Hero comes with 20 phases capable of handling up to 90 amps each with some intelligent cooling built in, and enough headers and memory support on board to make even the most enthusiastic of peripheral product proponents happy.
$700, www.asus.com

MAXIMUS DARK HERO
SUPREMEFX

SSD

1TB ADATA LEGEND 960 MAX M.2 PCIE 4.0 SSD

Our SSD pick is more subdued than some of the other options, but then, it didn't need to be the be-all and end-all of this build. We've gone with a trusty Adata Legend 960 Max in a 1TB config. Sequentials are fairly solid, clocking 7400 MB/s read, and 6800 MB/s writes there, with 4K Random IOPS tapping out at 750K and 630K respectively.

We could have gone for something a little more punchy, but given the temperature constraints and power-draw those drives currently have, we decided against it this time around.
$70, www.adata.com

RAM

32GB (2X16GB) CORSAIR VENGEANCE DDR5 @ 4800

For our memory selection, we've gone for this kit from Corsair. This 32GB of Vengeance DDR5 clocks in at 4800 MT/s, but is more than capable of doing what we want. 32GB is the ideal sweet spot, and although there are a few titles that benefit from that additional capacity (some testing suggests that minimum frame rates can increase at certain resolutions), it's not quite enough for us to warrant a larger-capacity kit.

At $100, this kit is an absolute treat. That said, thanks to the incredible grunt of Intel's latest memory controller found on the 14th gen, plus the now well-matured BIOS on the Z790 chipset, there's absolutely room for improvement here.
$100, www.corsair.com

CPU Cooler

NZXT KRAKEN X73 RGB 360MM AIO

To get the most out of your Intel 14900K, Team Blue recommends having, at minimum, a 360mm AIO liquid cooler. Inevitably, it's going to generate a lot of heat in the process. To allow for that, we've decided to pick up this. It's decked all in white, with some RGB fans. It also allows us to take advantage of NZXT's CAM software, which remains one of the slickest system-monitoring programs.
$150, www.nzxt.com

ALTERNATE MEMORY OPTIONS

The curse of photoshoot deadlines strikes again, this time in the memory department. We did intend to run a slightly different memory kit with this build, but due to time constraints and shipping being mildly problematic (our kit spent two whole weeks in Hong Kong), it didn't make the cut.

So what's the recommendation? 32GB (2x16GB) Corsair Dominator Titanium DDR5 in black at a whopping 7200 MT/s. Why does that matter? Simply put, we've heard a lot of reports that Intel's 14th gen is a monster when it comes to memory overclocking. With the right memory, some of our colleagues and competitors have managed to take that same kit and ramp it up to 8,000 MT/s, and with some mild tweaks, push it to 8,600 MT/s. Finally, DDR5 is starting to show its potential.

Does that cost a lot more? Not entirely. A 7200 MT/s Dominator Titanium kit at 32GB will set you back around $220. When you consider that real-world latency will drop from 16.667 ns to 9.444 ns at that stock speed (and potentially half that, overclocked), it suddenly becomes a lot more reasonable.

These kind of latency improvements are significant, particularly in anything that really pushes those theoretical simulations or larger datasets that require rapid memory read and writes on the fly. In-game, you'll see some significant benefits, typically at lower resolutions and higher frame rates, or in titles that simulate a large number of particles or models at any one time.

DOMINATOR
TITANIUM
DDR5

© CORSAIR

Airflow Fans

3X CORSAIR LL120 WHITE **$83**

Static Pressure Fans

3X CORSAIR SP RGB ELITE 120MM **$65**

Fan Controller

CORSAIR COMMANDER CORE **$40**

Our cooling setup involves nine 120mm fans: three SP fans from Corsair, three LL fans from Corsair, and three RGB Aer fans from NZXT. The Corsair units run via a Commander Core fan and RGB controller, the remaining NZXT fans via the motherboard for fan speeds, and the Kraken cooler for the RGB.Thanks to the multiple fan-mounting locations, it's given us flexibility for placement. *www.corsair.com, www.nzxt.com*

Case

NZXT H9 FLOW ATX MID TOWER BLACK

For the price of that graphics card, you could buy ten of these cases. The NZXT H9 Flow is a fine chassis, and follows in the long line of 'fish-tank' cases that seem to be all the rage. The Lian Li PC 011 Dynamic may have popularized this, but everyone's jumping on the bandwagon these days, and with good reason. It's a highly versatile, yet somewhat chunky, style of chassis with some significant cooling and build potential.

Take the H9 Flow. With two glass panels on the front and side, you get fantastic visibility of all of your expensive hardware, but NZXT hasn't forsaken cooling. You've got 1.5 inches of ground clearance for those triple 120mm bottom-mounted fans, support for three 120mm fans in the side, space in the roof for exhausts, 120mm in the rear, extensive cable routing space, some exceptional capacity for vertical GPUs, and more. This is a great case for those looking to really minimize their cable management efforts. *$160, www.nzxt.com*

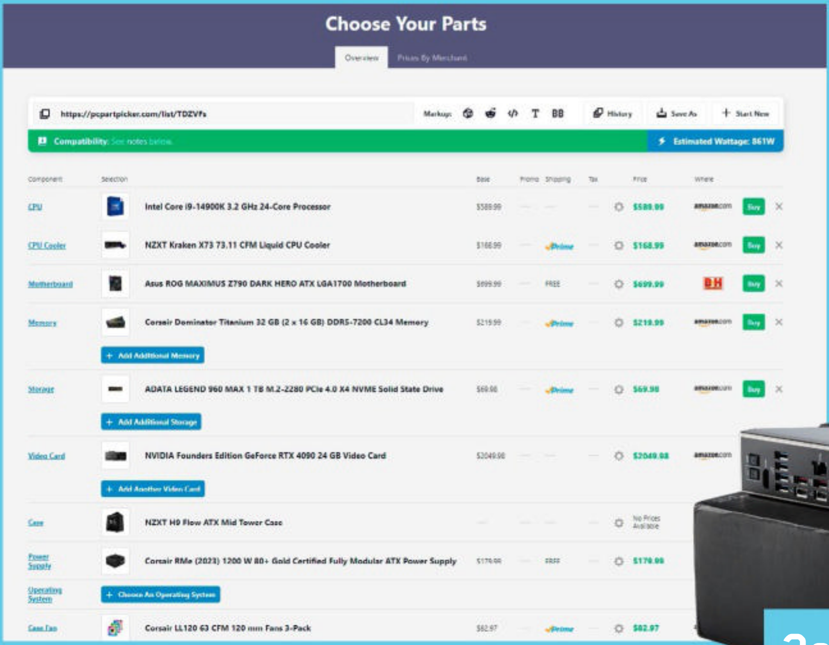
PSU

1200W CORSAIR RMX SHIFT 80+ GOLD

Another Corsair part comes in the form of the RMx Shift PSU. The connectors have been shifted to the side of the power supply, giving you easier access for cable routing. Corsair's managed this by developing a super-small form factor cable (the Type 5) that's found on its latest SFX PSUs as well.

More importantly, this complies with Intel's ATX 3.0 certification, so it's highly efficient. It also comes with a PCIe 5.0 12VHPWR600 cable as standard. We're not talking about any funky adapters; this is a fleshed-out direct PCIe to 12VHPWR cable, reducing potential failure points that might occur from overheating or cable installation mishaps. *$230, www.corsair.com*

THE NEXT GENERATION



Choose Your Parts

Compatibility: See notes below.

Estimated Wattage: 861W

Component	Selection	Base	Promo	Shipping	Tax	Price	Where
CPU	Intel Core i9-14900K 3.2 GHz 24-Core Processor	$589.99	—	—	—	$589.99	amazon.com
CPU Cooler	NZXT Kraken X73 73.11 CFM Liquid CPU Cooler	$168.99	—	Prime	—	$168.99	amazon.com
Motherboard	Asus ROG MAXIMUS Z790 DARK HERO ATX LGA1700 Motherboard	$699.99	—	FREE	—	$699.99	B&H
Memory	Corsair Dominator Titanium 32 GB (2 x 16 GB) DDR5-7200 CL34 Memory	$219.99	—	Prime	—	$219.99	amazon.com
	+ Add Additional Memory						
Storage	ADATA LEGEND 960 MAX 1 TB M.2-2280 PCIe 4.0 X4 NVME Solid State Drive	$69.98	—	Prime	—	$69.98	amazon.com
	+ Add Additional Storage						
Video Card	NVIDIA Founders Edition GeForce RTX 4090 24 GB Video Card	$2049.98	—	—	—	$2049.98	amazon.com
	+ Add Another Video Card						
Case	NZXT H9 Flow ATX Mid Tower Case	—	—	—	—	No Prices Available	
Power Supply	Corsair RMe (2023) 1200 W 80+ Gold Certified Fully Modular ATX Power Supply	$179.99	—	FREE	—	$179.99	
Operating System	+ Choose An Operating System						
Case Fan	Corsair LL120 63 CFM 120 mm Fans 3-Pack	$82.97	—	Prime	—	$82.97	

1

ROG MAXIMUS Z790 DARK HERO

2a

LENGTH OF TIME: 1-2 hours
DIFFICULTY: Easy

Building your own system has come a long, long way in the last few years, and it's something we highly recommend. Yes, you could buy a prebuilt rig from the likes of Origin, iBuyPower, or any of the other reputable manufacturers out there, and you can customize that too, but there's just something about getting your hands dirty and building your own machine that is just so rewarding.

There's more to it than that, of course. Over time, you'll discover that those same components (as ridiculous as this may sound) have a personality, like that old car that you love, or a padlock that you have to shake a certain way to get it to budge. These processors and parts are unique. Pushing them to their limits will give you a better understanding of them, and a better insight into how they perform. We can thank the silicon lottery for that, and it's why for many, this writer included, we have parts that hold a special place in our hearts. A Core i5-2500K that broke 5.4 GHz, an 8086K that smashed 6 GHz, a Ryzen 7 1700 that clocked as high as an 1800X, a GTX 660 that could eek out 12 percent performance boosts, a liquid-cooled Fury X, a 6700K that would run at 42 C under coolant with the voltage set super low. Will the 14900K join those ranks?

When it came to this build, we wanted to keep it straightforward and make it an everyman's rig, with simple parts, plenty of cable management, multitudes of convenience picks, and hardware you could swap out on the fly to really fine-tune it for exactly what you need it to do.

Don't get us wrong, building a liquid-cooled, bespoke, one-off, all-singing-and-dancing system definitely has its merits for a main-stream product launch like this. But this was less about building the ultimate gaming PC, and seeing how low we could get the fan speeds, and more about identifying how Intel's latest generation of processors compares to the last gen—really getting into the weeds, and putting that potent Core i9-14900K under the microscope. We'll have a bit more of a breakdown on what we'd swap out later on, but just keep in mind that this is more of a template, rather than a 'build this' kind of build. In fact, that's always something we'd recommend with any system we write about here.

Pre-build planning & PC part picker

Nothing is more important when it comes to building a PC than the preparation beforehand. It's here where every good system will live or die, and where painful, costly mistakes can be made before you have even had the parts delivered.

Let's ignore the budget side of things for the time being. The things you need to think about are many and interconnected. For us, it's quite easy—a new processor comes out, and we spec the build around that. New Intel 14900K? Simple—14900K build. It'll need a big cooler, because it's a hot chip (we assume), plus we'll need fans to support that, and a case with good airflow. Then the GPU? Probably something top-end to really try and bottleneck the CPU on the low-end and see what the limits are. RTX 4090 or 7900 XTX, then. That's a lot of power draw, so we'll need a decent PSU to supply all the juice. 1200W ATX unit? Sounds good. Do we want to focus on storage? No? Drop the SSD focus, and go for something reliable and cool. Gen 4 will do.

These questions come about quickly, but when you're on the other side of the fence, and not generating content for an internationally successful PC magazine, with access to more hardware on the shelves than your average human, where do you begin? With two questions. Firstly, what's your budget? Secondly, what do you need it for? Once those two elements are established, you can start planning out your build.

Do you just want to play games? A quick bit of research in this title and on the web will tell you that a Core i5 or Ryzen X3D chip is the way to go. Really into rendering

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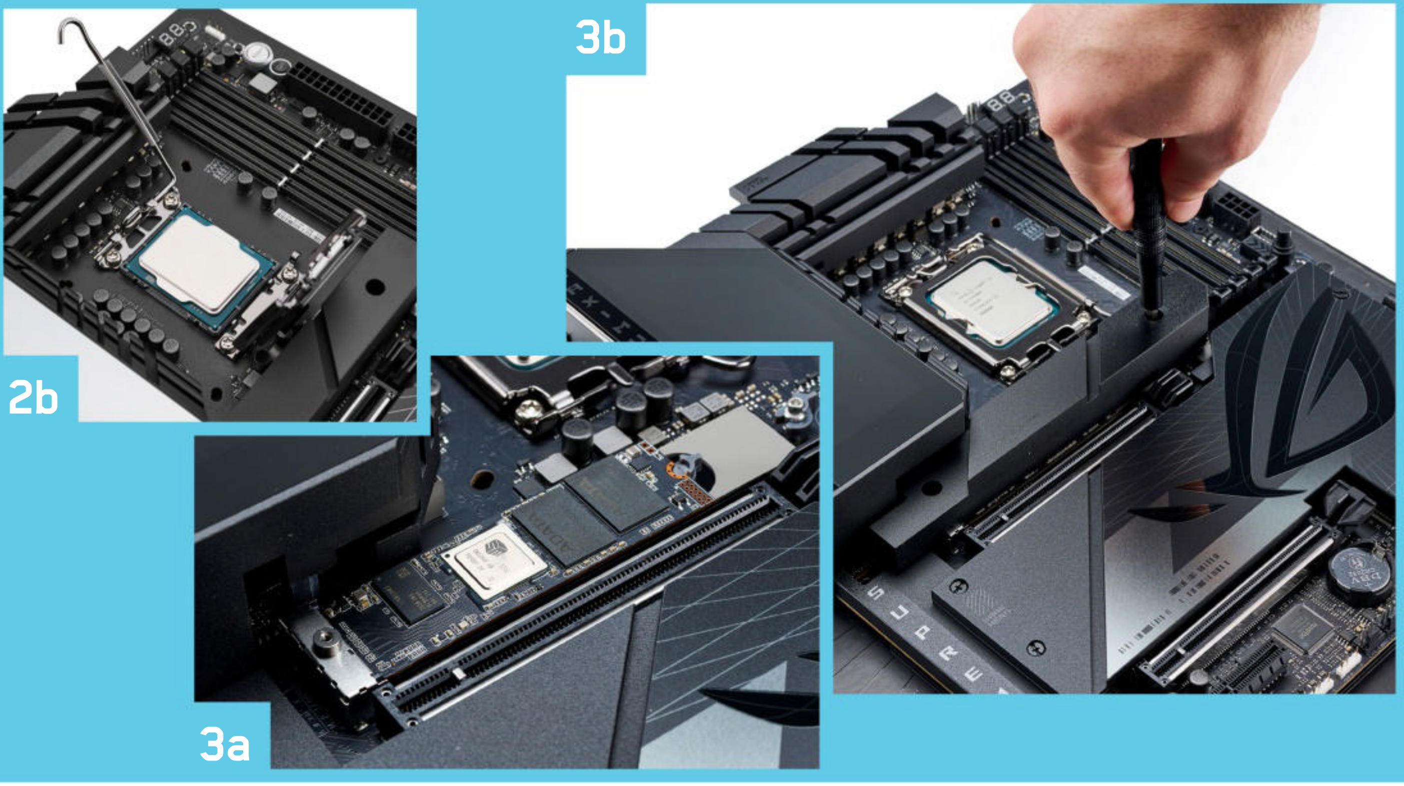

and multi-threaded tasks? A standard Ryzen or high-end Intel processor will be recommended. Working on massive video files, and scrubbing through 4K footage? High-speed, high-capacity DDR5 needs to be on the cards, along with some significantly rapid internal storage. What about gaming? 1080p will be ideal, but high refresh rates will be king, so 4070 or above. Play a bit of everything? Then find the GPU right for that.

Once your CPU, GPU, RAM, and SSD are picked, then you can worry about the rest. Power supply next, a motherboard that supports all that, and cooling around that will net you a decent system pretty rapidly. "But what about compatibility issues?" I hear you ask. That's where PC Part Picker comes in. Head to pcpartpicker.com, enter your hardware in there, then scroll down to the bottom and check the compatibility notes. Better yet, it won't let you pick certain hardware that isn't compatible, making it a far easier affair. But enough about your next project—let's get on with this one.

1 Chassis stripdown

She's a thing of beauty, the H9 Flow. We've seen a fair few fish-bowl cases at this point, but the H9 is arguably one of the best (if not slightly chunky). Whether that's ease of access to those panels, or in-built features, that's not an element of this thing that disappoints.

First and foremost, after prepping your work area (obligatory "don't build a PC on a carpet while wearing woolen socks and your best cashmere sweatshirt" comment), you're going to want to strip down your case as soon as you can.

Carefully remove the glass side panels and the rear panel, along with the one on the roof as well. You can also remove the dust filter on the underside of the case (you'll need to if you plan on installing any floor-mounted fans for this).

We've also gone ahead and removed the side-fan bracket [**Image 1**], but left the top-mounted radiator bracket in for now. You could also remove the front panel once that's all done. But again, as we're not really working around that too much (no front fans), we've opted not to do that in this instance. Store all those panels in your case box, using the polystyrene shipping foam in between them so they don't get scratched, damaged, or lost.

2 Motherboard prepping

It's time to crack out the ROG Maximus Z790 Dark Hero and start work on getting this thing ready for installation into the H9 Flow. Now, we're going to install as much as we can outside of the case first, just to make it a little easier for maneuvering once we're in.

Ideally, when building your own system, at this stage you want to be thinking about your M.2 storage, CPU, and any cooling brackets you might have. You can technically install your memory at this stage as well, but honestly, unless you're building a hard-lined liquid-cooled PC that has tubing running directly over the memory DIMMs, leaving it until the motherboard is installed in the PC is actually the far safer option. The reason for this is that you're less likely to accidentally hit, bend, or nudge them while installing the motherboard.

We've placed our Z790 Dark Hero on its packaging box while we do this work [**Image 2a**]. This is for two reasons. Firstly, it's convenient, secondly, it's also a safe place for it to sit, that doesn't generate static. Also, please don't ever place a graphics card or a motherboard on the outside of an anti-static bag. They're anti-static because the outside of the bag is conductive, not the inside.

To install your shiny new Intel Core i9-14900K processor (or any LGA1700 chip), simply lift the retention arm to the side and out of its locked position, then raise the securing bracket up and out of the way. You'll be left greeting a very delicate array of contacts, designed to transfer data from your CPU to the motherboard

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and back. Don't touch that. Next, pick up your CPU, and carefully place it down into the socket [**Image 2b**]. Don't force it, or try and make it click or anything; just place it, making sure to align the notches at the bottom and the top, and ensuring that it's oriented correctly (the model number etched into the IHS, should read left-to-right, with the motherboard facing up, there's also a golden triangle on the bottom left side of the CPU, that aligns with a notch on the bracket).

Once complete, place repeat in reverse, place the bracket back down, and secure in place with the retention arm, and the plastic cover will then pop off. If it doesn't, carefully pull it off, and store it for later. This is useful if you need to send the mobo back for diagnostics.

3 M.2 installation

Next up on the to-do list is the M.2 storage. For future reference, unless otherwise stated, your fastest, primary M.2 should always be located in the M.2 slot closest to your CPU. This is almost always going to be the quickest slot—not only will it likely have the latest PCIe gen support on it (some boards, have multiple generations of slots across them), but these slots are often the ones with dedicated PCIe lanes direct to the CPU as well. This means they don't have to share them with other peripheral devices, such as SATA SSDs or other PCIe components.

There is one other minor consideration to make here, and that's with the cooling. GPUs are typically sat below this top slot, obviously, they do get hot, and heat travels up. This can affect performance, but only to a certain degree. M.2 SSDs are an odd mix of memory, generally speaking, the flash controller, typically prefers lower temps, while the NAND storage itself usually prefers higher from an operational standpoint.

The Z790 Dark Hero comes with a heatsink installed by default on the top M.2 slot—simply take out the two screws on either end, and lift it up and off the motherboard. You'll notice that it has a thermal pad underneath. That pad has a layer of plastic film over it to prevent contamination. Remove the film, and place the heatsink down for later. Then, grab your M.2 drive and carefully slide it into the M.2 slot, paying attention to the notch on the drive, and the notch on the slot itself [**Image 3a**]. You'll notice that Asus motherboards have this nifty plastic securing device instead of a screw to lock the drive in place—turn that around, and it'll keep the drive secure. Then, it's simply a case of replacing the heatsink we removed earlier, and your job here is done [**Image 3b**].

4 CPU cooler backplates

Next up on the agenda is the mounting hardware for that Kraken CPU cooler. Always triple-check the manual before proceeding, and identify the correct mounting hardware for your socket (these should be in little labeled bags in your CPU cooler box). In our case, we need the Intel motherboard backplate and the LGA1700 screws. Once you have these, take your backplate and adjust the standoffs so they fit through the mounting holes on the motherboard. Then, use the screws supplied to secure them in place [**Image 4**], and you'll be done.

One thing to note: in some instances, the coolers won't require any additional mounting hardware for LGA 1700. Although the socket itself is physically bigger than its predecessor LGA 1200, the socket mounting locations haven't changed (still a 75mm square effectively). In this case, we're actually using LGA 1200 standoffs, as the 1700 set has gone walkabout, and have yet to see any negative impact from that whatsoever [**Image 4**].

5 Motherboard goes in

Now that's out of the way, it's time to get this motherboard into its new home. As our chassis is mostly stripped of anything that might

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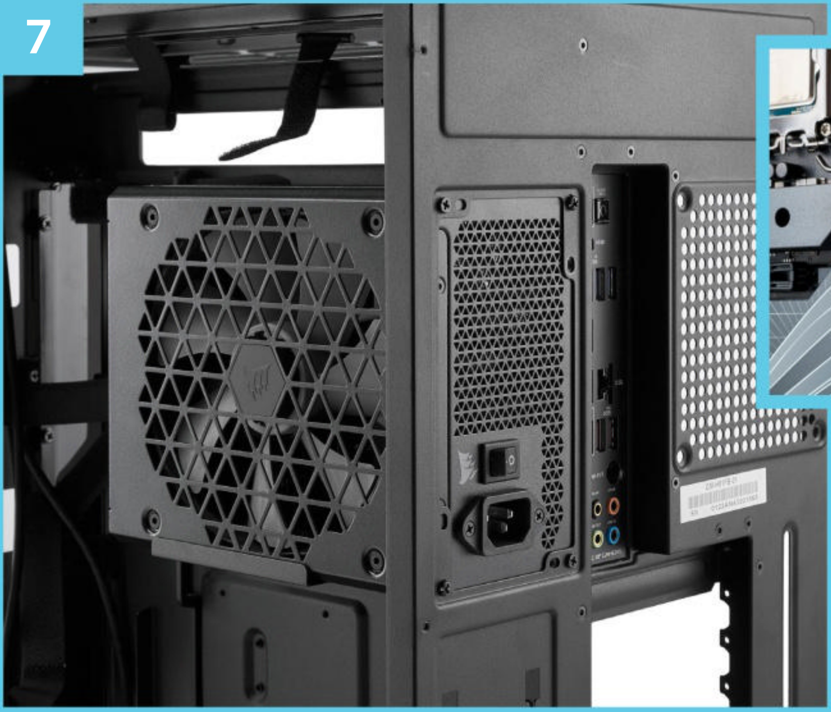

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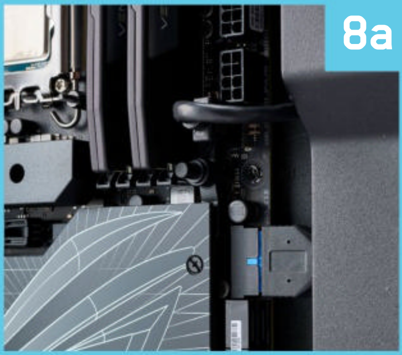

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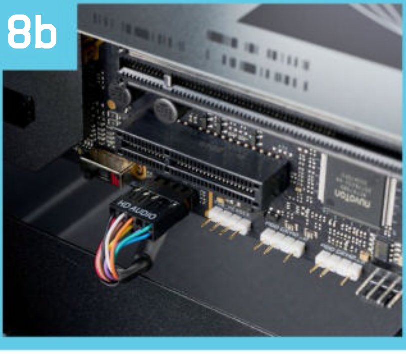


break or get scratched, losing a few pounds in the process, it makes it far easier to move around and get into.

Tip the case onto its side so it's laying flat, then carefully place the motherboard into the case so it sits on top of the standoffs. There's a center standoff 'pin' that'll help secure it into position, along with the rear I/O slot.

Inside your chassis box should be a small bag of screws. In here you'll find some of those that you can then use to secure the motherboard into position through the standoff holes [**Image 5**]. There's no magic trick to getting these secure—just don't overtighten them. There's nothing worse than having to remove a motherboard from a case and for the standoff to start spinning because the screw is stuck.

6 Memory mastery

With the motherboard nice and secure in the chassis, it's time to get that memory in. This is a super-simple process for the build itself, but there are two things to bear in mind here, one you should be thinking about really in the planning stages. Firstly, DDR5 is still a tricky beast that has developed rapidly since its launch. One thing it's still not great at, however, is quad stick kits. If you want four sticks of memory, make sure you buy a kit from the get go that supports that. We've heard numerous reports of users buying two identical 2x16GB kits at the same speed, in the hopes of installing four identical DIMMs in their motherboard, only to be left with a system that doesn't boot with them in, or one that can only run at 4000 MT/s.

Yes, you've guessed it, those quad stick kits cost more as well. We've been told that this is due to DDR5 being particularly finicky, and these kits predominantly require pre-binning before pairing together. Alternatively, some manufacturers sell 'dummy' kits that'll solely fill the remaining two slots, but look identical to the memory kits, even with controllable RGB, if your build anxiety is really playing up.

The second element we mentioned is slot placements. Similar to past generations, these need to be done in odd or even pairs. We recommend the second and fourth slots away from the CPU for cooler compatibility. To install the memory, lift the latches at the top of the memory slots (Asus boards typically only use one latch at the top of the motherboard, while MSI and Gigabyte often use two sets). Then, paying special attention to aligning the notch, place the stick into position until it clicks in place and the latch secures down. Rinse and repeat until you're done. [**Image 6**]

7 PSU inversions

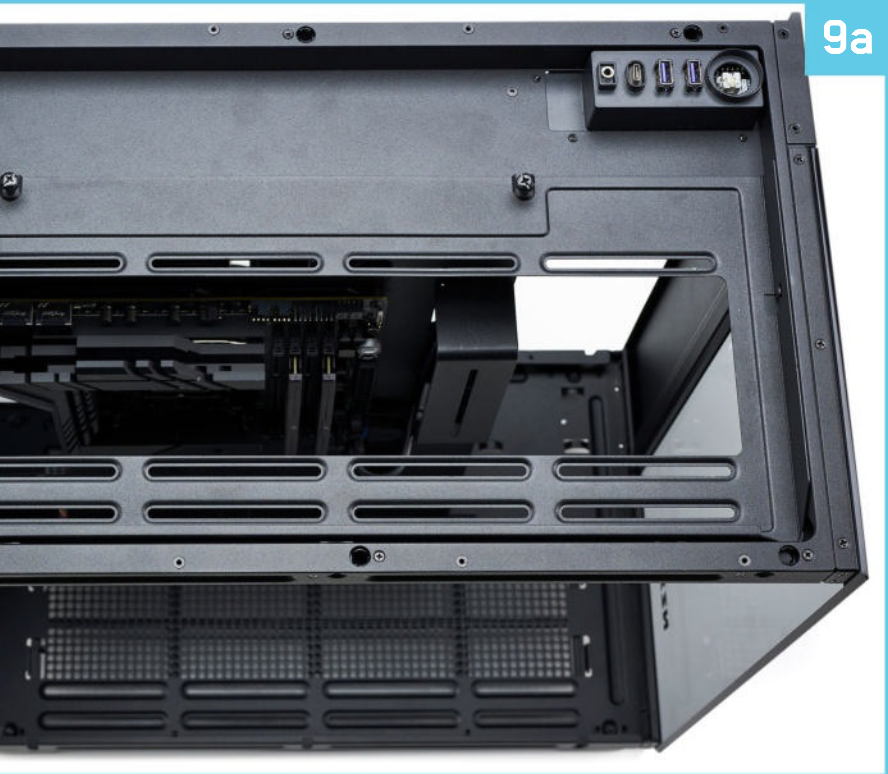
Don't do what we did—it just produces headaches. What's that exactly? RMx Shift in a chassis that rotates the PSU by default onto its side. The advantage of an RMx Shift is that its PSU connectors are on the side of the unit, not the back (spotted on the top side of **Image 7**). In any other case where the PSU lays flat with the fan mounted below the case, that's great. In this case, you entirely lose the advantage of those sideways-facing connectors.

Now admittedly, we do have that future-proofing capacity if we need to change to another case in the future, but here it's entirely disadvantageous. You'd be much better off getting a standard RMe or RMx if you're planning on building out this system.

Fortunately, this time around, there's enough spacing above the power supply itself for us to easily run cables through.

8 Easy cable wins

With a 'successful' test-fit and mild panic attack averted with the PSU, we went ahead and plugged in as much of the IO as we could. First in is this right-angled USB 3.0 header (always a blessing these), which helps us hide that bulky cable. Unfortunately, Asus hasn't quite managed to develop a right-angled USB Type-C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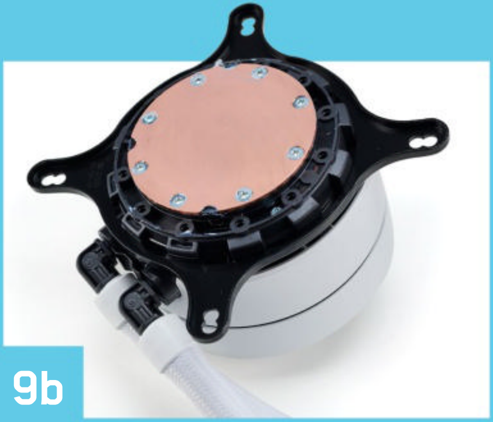
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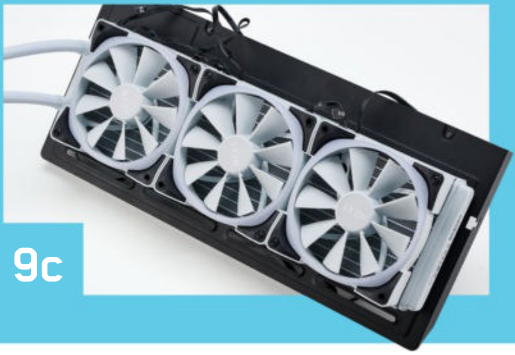
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cable just yet, but that still fits in quite nicely [**Image 8a**].

Next up on the list of front panel connectors is the HD Audio passthrough [**Image 8b**]. These have a pin missing by default, and are easy to align. Generally speaking, we'd actually recommend that you don't install this. If you're after top-quality audio, the last thing you want to be doing is routing that sound through a passthrough attached to a giant metal box. The amount of times we've had issues with crackly audio coming through headsets on the passthrough is just absurd. It doesn't matter the manufacturer, the motherboard, or the case, it just vastly reduces the quality compared to plugging that headset directly into the back of the motherboard itself.

The best thing you can do is either tie this up and stick it out of the way in the back of the case somewhere and ignore it. We've also installed the front panel headers here. Fortunately, NZXT uses a full block connector to make things easy, but if you're using a different chassis, you'll need to refer to the motherboard manual to identify which pins you need to connect with the right header.

9

Cooling mount-up

On to the next step. This time, it's all about getting that cooling in and live. We're running a big tripe rad on this one—360mm of pure grunt, capable of keeping even the headiest of processors chilled (or at least, that's the theory). The H9 Flow comes with a removable radiator mount in the roof of the case [**Image 9a**]. Simply undo the thumbscrews, remove the securing screws at the front and rear of the chassis, and remove it from the case.

Next, we're going to prep the right bracket for our cooler's CPU block mount. Grab the Intel bracket we set aside earlier, slot it onto the block through the notches, rotate slightly to the right, pull it down and it'll lock into place [**Image 9b**]. One thing to keep in mind is the orientation of the tubes with the bracket itself. Make sure you don't place the mounting holes between the two, or you're going to have a really awkward time later on.

With that sorted, it's now time to mount the cooler to the radiator bracket and install the fans. For this, place the radiator on the edge of a table or worktop, with the tubing and cpu block dangling down off the side, and the radiator laying flat on the table. This will make it infinitely easier to mount it to the removable radiator bracket. Then, using the screws provided in the NZXT chassis box, mount it to the bracket—one screw in each corner, plus a couple in the middle should be enough. If the build is going to be traveling (or being couriered), install all the screws.

Once that's out of the way, now is a great opportunity to attach the fans to the system. The NZXT fans included come with a daisy-chain RGB system, which helps mitigate the number of cables, but you still have three PWM connectors, and an RGB cable to worry about. Always keep in mind the orientation of your fans and the cables prior to installation. You'll notice here that we've positioned the fans so that all of their cables are facing toward the rear of the case or the cable-management area of the chassis. It's these small details that will help keep your build looking cleaner and easier to manage in the long run [**Image 9c**].

10

In she goes

With the cooler mounted to the bracket, it's time to get this in the chassis. With the case upright, slide the radiator and bracket through the top of the chassis, being sure not to scratch or damage any components with the CPU block. Once in, secure the radiator bracket with those thumb screws and additional side screws.

Then, holding the CPU block, carefully lay the case back onto its side and place the block down on a non-hardware side of the case. Your CPU block should come with thermal paste pre-applied, in which case ignore this next step. If it doesn't, you'll need to grab a tube of thermal

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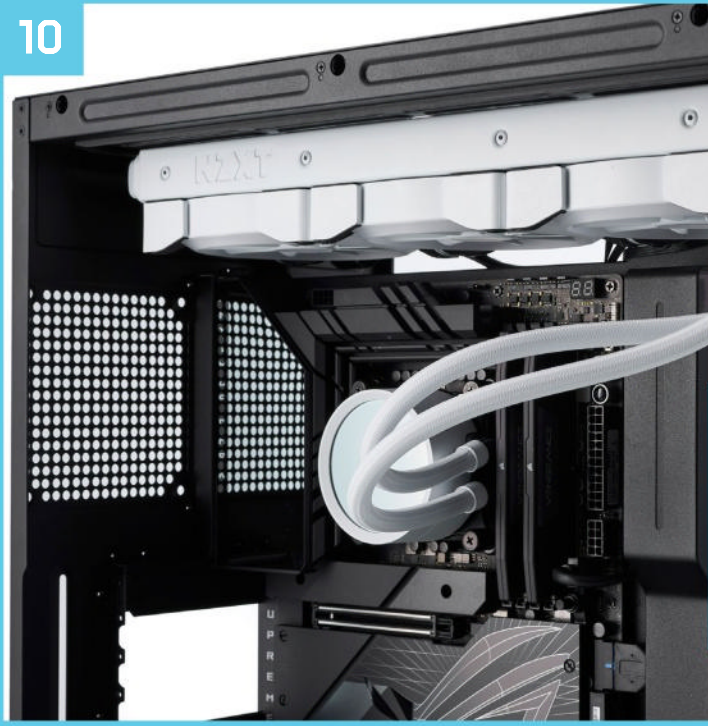

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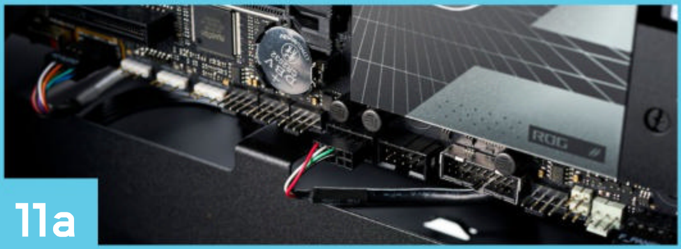

paste (we recommend Noctua's NT-H1), and place a large blob in the middle of your processor. Then, carefully place the cooler on top of those mounting standoffs we installed earlier.

Using the included thumbscrews, install the block onto the CPU. Install each screw a little bit at a time at first, until all four are on. Then, with that out of the way, tighten them in a diagonal pattern until the thumbscrew reaches the end of its thread. Do this by hand, otherwise you could end up damaging the CPU or the motherboard in the process. [**Image 10**].

11

Cable Trickery

The only downside to a lot of AIOs is the number of cables that need routing from the CPU block itself. NZXT's Kraken here is no different. We've got two total to contend with—one a Micro-USB, the other a proprietary number. If you have the tubing set to the right, then these cable locations will be at the top side of the block.

One of the neat tricks with the Kraken X73 is the fact that you can rotate the infinity mirror and logo on the board itself, simply by rotating the top section of the cooler. Combined with the flexible nature of attaching the Intel or AMD bracket in different orientations on the circular block as well, and theoretically this does give you a little wiggle room to play with during the mourning process to help with those two cables. However, in our build, we'd have ideally wanted to rotate the entire unit by about 90 degrees to the right, which would have pulled our tubing down below the CPU block, and potentially stretched that bottommost tube out.

So what does this mean for our cabling? Well, we've grabbed our Micro USB to USB, and routed that up around the VRM heatsink. Then, we've unsecured the motherboard itself, and ran the cable directly behind the motherboard, between it and the motherboard tray. This gives us a tidier cable run, allowing us to plug it into the USB 2.0 header at the bottom of the board [**Image 11a**], without having to dodge around the PSU and all that extra cabling in the back [**Image 11b**]. We've re-secured the motherboard standoffs down after the fact, and the job is done.

We have tied up our proprietary cable, and ran it into the back of the chassis. This has the SATA power, RGB header for the fans, and PWM header for the pump—you simply need to connect them to their relevant headers, and you're done. We've also gone ahead and routed the rest of the PSU cables here. That's two EPS 8-pins in the top of the system, the 24-pin power, an additional 8-pin PCIe power (situated next to the 24-pin) for additional PCIe juice support, and pre-routed the 12VHPWR600W cable as well.

12

Cool Runnings

We're taking advantage of all those fan mounts in the H9 Flow. The plan is simple: three in the roof as an exhaust (thanks AIO), three on the side as exhaust, with another removable fan bracket [**Image 12a**], and three in the floor as intake [**Image 12b**]. This will inevitably lead to a negative air pressure system, but we're countering that, as the bottom floor fans will be running at a slightly higher RPM than the other units.

There's not a whole lot to cover here, but one standout element was the bottom fans, which required being secured from the bottom of the case, and not having a removable rail of some description. That does mean that you have to tip the entire chassis on to its side to mount these into place, which can prove to be a little frustrating. Similarly to the CPU cooling setup, make sure that the fan cables are oriented in the best possible manner to route those cables in order to the rear of the case.

Once those six Corsair units are in place, you simply have to plug them into the Commander Core unit 1-6, and you're good to go. One thing that's worth pointing out with the Commander Core is that if

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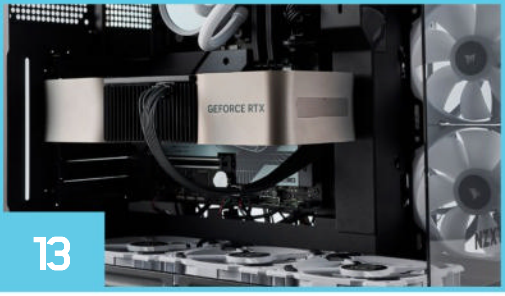

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you're not populating every header, they need to go in, in sequence 1, 2, 3, 4, and so on. If you try to plug them into any header, and leave one out, they won't be detected by iCUE.

13 Monster Graphics Cards

The final piece of the puzzle is the RTX 4090 install. We've already pre-routed the cable, and removed the rear PCIe slot covers for this. Fortunately, Asus has a little push button to unlock and lock the top PCIe slot as well. With the chassis on its side, place the GPU in position while holding the button down. Once it's clicked in and secure, release the button, and you'll have locked the GPU into the slot. Then, secure the card down at the PCIe slot again, using all three screws (make sure these are tight, this is a big card, and there's a lot of weight there). Finally, install that 12VPWR600 cable into position, and you'll be good to go [Image 13].

We can't stress enough, make sure this is fully inserted all the way, with no gaps. The reason cables initially had issues were myriad, but the vast majority came from either faulty adapter soldering, or partial insertion into the power port. With that finished, all that's left to do is pop on all the side panels, and dust filters, and you're finished.

THE '*RIGHT*' BUILD ORDER

If anyone ever tells you there's a "build order" to these kind of things, please give them a good shake. Each build is different and dependent on parts, clearances, and multiple other factors—each system is going to be built slightly differently, or, benefit from a different construction process.

Take this build, for example. We could have installed the PSU last and ran the cables then, once the fans were already installed, and the graphics card in place. Instead, we opted to pre-run the cables before all of that. We could have also installed those cables prior to the installation of the cooler (to help get access to those top EPS power connectors for the motherboard), but given the clearance at the top of the chassis, decided against it. We also could have installed the memory outside of the chassis during the motherboard prep phase, but that could have led to knocking it during installation.

Is this the most optimal way of building in the H9 Flow with these parts? Well, that entirely depends on the builder, and how your mind logically works with the build itself, what your process is, what you want to do with it, and how you want your cable management to run. Ultimately, that's the key—as long as you take your time, think about each step logically, and don't just try to brute-force your way through it, you'll end up with (hopefully) a painless build that's just right for you, without too much stress.

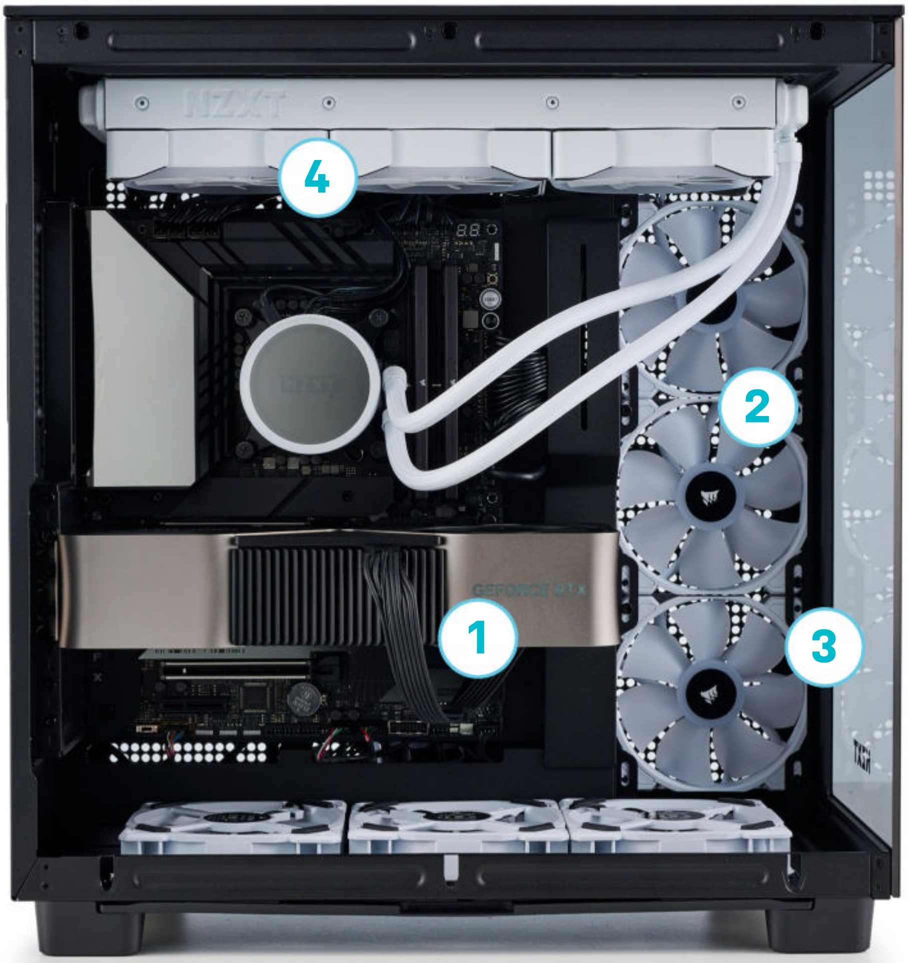
There are a few general best practices we'd always recommend, such as stripping the case, installing the CPU outside of the build first, and installing the graphics card last—things along those lines, but again, the order you do this is entirely up to you and your interpretation of the process. Don't sweat the small stuff; just have fun, and build yourself a kick-ass rig.

CAPTAIN'S LOG STARDATE 14900K

IT'S NICE from time to time to build a system that doesn't really require too much thought. There weren't a whole lot of problems to solve with the NZXT H9 Flow, if any. That's the highest compliment to a chassis and its design team. Building inside of the H9 Flow was ultimately painless. Fan placements were good, radiator installation was easy, and motherboard setup wasn't a problem. Once we worked our way around a particularly odd combo in the PSU department (okay, matching a rotated PSU with a chassis that rotates the PSU by design isn't exactly smart), it was pretty much smooth sailing from there.

That said, there are a few things we'd change with the build in general—firstly, the fan setup. Having multiple brands at this stage, with the RGB suites being what they are, is quite annoying, particularly as you need more RGB hubs to control it, and potentially have conflicts with software suites to think about. In an ideal world, we'd have loved to get some of Corsair's iCUE Link hardware in (think daisy-chainable cooling solutions, with a single cable/hub throughout for up to 14 devices), or something from Lian Li or Phanteks. On top of that, a custom cable kit would really make this build pop, too.

The only other bugbear we have is the number of front I/O cables attached, and of course, that Dominator Titanium memory not turning up in time for the final reveal in the photo shoot. That said, it did land while we wrote this piece, and it is now in the machine. All the benchmarks in the following graphs are using the memory we priced up at the beginning of this build, but we will cover what differences the 7200 MT/s kit makes shortly.



1 You can get a number of sleeved and alternative 12VHPWR cables for the RTX 4090 now, that look a lot better than these and come with added protection. That said, always make sure yours is connected fully, and you should be fine.

2 White fans throughout look great, but in an ideal world we'd prefer to have consistency with fan manufacturer here to simplify the RGB setup and provide consistent airflow across the system.

3 The H9 Flow's rear panel is almost completely perforated to allow for maximum airflow across the rear of the case, right behind these side fans. It's an impressive feature and helps it draw air in for your hardware.

4 In hindsight, we should have perhaps been a bit more savvy with the CPU cooler to get those cable ports closer to the top right, and next to the memory. This could have given us a cleaner look overall.

BENCHMARKS

	ZERO-POINT	
Cinebench R23 Single-Core (Index)	2,247	2,204 (-2%)
Cinebench R23 Multi-Core (Index)	35,457	36,815 (4%)
CrystalDisk QD32 Sequential Read (MB/s)	7,057	7,138 (1%)
CrystalDisk QD32 Sequential Write (MB/s)	5,303	6,299 (19%)
3DMark Fire Strike Ultra (Index)	24,528	24,114 (-2%)
Cyberpunk 2077 (fps)	78	103 (32%)
Cyberpunk 2077 RTX (fps)	43	69 (60%)
Metro Exodus (fps)	140	133 (-5%)
Metro Exodus RTX (fps)	105	109 (4%)
Total War: Three Kingdoms (fps)	100	95 (-5%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point consists of the 8K Gaming Monster from our Holiday 2022 issue, featuring an Intel Core i9-13900K, MSI GeForce RTX 4090 Gaming X Trio 24GB, Asus ROG Maximus Z790 Hero Mothernoard, 32GB (2x16GB) of Corsair Vengeance DDR5-5200, and 1TB PNY XLR8 CS3140 PCIe 4.0 M.2 SSD. All games tested at 4K 'Ultra' graphics presets with DLSS and V-sync turned off and XMP for RAM speed turned on. No manual CPU overclocking.w

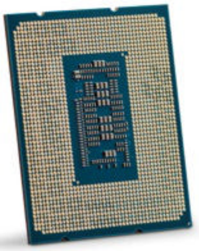
GENERATIONAL BLUNDER OR EVOLUTIONARY ADVANCEMENT?

INTEL'S 14TH GEN has been a pretty poorly received product since its launch. From a step-change standpoint, there's not really a lot to shout about. Yes, Intel has managed to do some interesting stuff when it comes to thread scheduling via its new APO tech (Application Optimization), but even that's a fairly minor addition at this point given it's only available for certain games and technologies (in fact, one of the two games it's enabled on is in our testing suite, *Metro Exodus*, and as you can see from our results, we're actually getting lower figures than from the MSI 8K build from our Holiday 2022 issue).

Compared to the 13900KS, or even the 13900K, there's just nothing here that really warrants upgrading to it, unless you're five or six generations behind at this point. The problem is that even then, given the high price point and lack of advancements, you're likely much better off picking up an Intel Core i9-13900K instead, as it'll undoubtedly become cheaper in the following months, particularly around Black Friday and Prime Day periods.

The one exception to that rule (and something picked up by the wider tech industry right now) is the Core i7-14700K, as it has now gained an additional four E-cores compared to last gen's 13700K. Although that's not exactly a huge hardware change, it's enough to see significant performance increases in more productivity-oriented programs and applications—in which case, it does make a case for itself, compared to the rest of the product stack.

But hold on to your horses, because there is still more to this chip than meets the eye. Viewed in isolation, outside of the world of us tech journos hammering Intel on every perpetual upgrade cycle, it is still a phenomenal piece of kit. Where AMD's processors excel in very different fields (the 7XXX series doing particularly well in multi-threaded tasks but falling behind in single-threaded performance and games, and the X3D parts going hell for leather and being true gaming kings compared to the competition), Intel is the perfect all-rounder. It's not far behind that of AMD's top flagships in either field and excels in others, particularly in single-core workloads that prefer higher clock speeds. It's that versatility, that jack of all trades, but master of none—an ethos that really cements it as a fantastic solution for any and all looking to dabble in a bit of everything on their next PC. The reality is that given the pricing of the Core i9-14900K and its masterful performance across a range of applications, it's still a solid choice for any top-tier custom PC—just not quite the jump we were hoping for.



RAPTOR LAKE REFRESHED

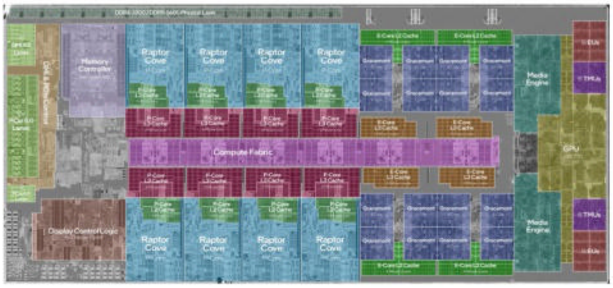
INTEL'S 14TH GENERATION ISN'T AS EXCITING AS YOU MIGHT EXPECT

INTEL'S LATEST PROCESSORS currently sit in an odd place, as they're a weird hybrid of monolithic chip design (boasting those impressive low latencies and power efficiency), while also having characteristics that are not entirely dissimilar to more modular layouts. Let's cover the bottom level.

P & E cores explained

With the advent of 12th gen, Intel introduced its first incarnation of this multi-architecture processor in the form of Alder Lake. Moving up to the LGA1700 socket, it didn't only increase the CPU size by doing so, it also reconfigured how the chip operated from the ground up. Namely, it stepped away from a more traditional brute-force core strategy, and opted for a streamlined processor that took advantage of two separate types of processor core, aptly named the P Core (performance core) and E Core (efficient core), with the aim being to leverage smarter resource applications than had been achieved previously with any processor at this point (AMD or Intel).

Simply put, P cores are the high-firing top-tier cores, complete with hyper-threading and full overclocking headroom, designed predominantly for high-priority tasks and games. Prior to 12th gen, these cores were pretty much all processors comprised, while the newly created E Cores were smaller, only capable of a single thread, and better suited to background or low-demand tasks that required less performance. Intel identified that the majority of users had a number of programs open at any one time, particularly during demanding workloads and tasks, and that this was negatively impacting performance by allocating partial resources of one or more cores into those low-end tasks. It was akin to taking a Dodge Charger, telling it to run a drag race, but every now and then stop and go to the shops. It would get the job done, but the stopping and starting increased latency and slowed down the processor, as Windows and Intel would be spending time allocating that resource to get the job done. To get around that, the E cores are dedicated to those more mundane tasks (running your antivirus, VOIP software, VPN, and Microsoft Office), while the P cores are used solely for the purpose of those high-priority tasks, such as gaming, rendering video content, and so forth.



Intel's Raptor Lake architecture in all its detailed glory.

This still requires those resources to be allocated, however. In 12th and 13th gen, that's predominantly managed by a combination of firmware/hardware and software side elements. Intel has its Thread Director (micro-controller), working in tandem with Task Scheduler found in Windows 10 and 11. Together, these look at the resources available to the system, and then allocate that resource to the program, depending on efficiency, demand, and a few select variables. It can identify low-priority tasks, allocate those E-Cores to effectively handle them, identify the more demanding applications, and allocate the P cores to them as well, in the process making the processor work smarter, rather than harder.

Next-generation resource allocation

APO (Application Optimization) is the direct successor to Thread Director, and exclusive to Window's 14th gen processors. Designed from the ground up to replace Intel's Thread Director and its interactions with Task Scheduler, APO acts more like a graphics driver, creating specific profiles on a per-app basis for more sophisticated resource allocation than what was possible before, as although Thread Director could do this on the fly, it didn't have the sophistication of APO. Thread Director was a springboard for Intel to pull resource insights from to better calibrate resource applications.

It is incredibly effective in comparison to its predecessor. Some applications see anywhere between a 15-35 percent uptick in performance when enabled. With time, this could be a game changer, particularly for CPU-bottlenecked games and applications, as it gives developers access to better optimization for products and games.

It's currently available on two gaming titles. One of them, *Metro Exodus*, saw performance improvements of close to 35 percent at 1080p in some user testing. If that can be translated to something like *Counter-Strike 2*, or better yet, video rendering applications, these performance boosts could be hugely significant, leading to smarter performance overall, and give Intel a real edge in the race to being the gaming king.

Not quite oven ready

The only problem is that the launch has been somewhat rushed. Similar to the problems we saw with Intel's 12th gen launch, APO currently supports a limited number of applications.

At the time of writing, it's only available in the Microsoft Store, only compatible with Windows 11, and only supported on the Core i9 and some Core i7 models. Fortunately, it's updated fairly frequently, and you won't need to worry about the updates quite as much as you would with a standard graphics driver. It also automatically scans for any programs or updates that it supports once installed.

XTU and AI advancements

It wouldn't be 2023 without some major company mentioning AI and how it's being integrated into its latest product stack, and Intel's been no different, this time with its XTU overclocking functionality.

For its 14th gen i9 processors, Intel now has a one-click button that effectively automatically overclocks your processor for optimal performance. If the cooling is sufficient and the cores operate within expected parameters, it can auto-overclock the lot within less than a minute to end up with stable performance

© WIKIMEDIA

increases across the board. It's not flawless, however, and we're still seeing better performance if we manually dial in the settings ourselves, but for those uninterested in the hassle of tweaking v-cores and clock speeds, this could be an alternative. It's worth pointing out that if you do decide to click that auto AI overclock button, you will still be voiding your warranty.

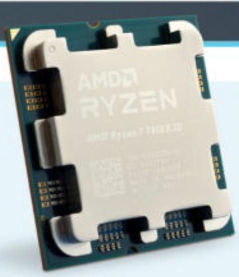
Will it ever become the default?

With the proliferation of AI in Intel's XTU and auto-overclocking feature sets being commonplace nowadays, when will we see this automatically enabled rather than an opt-in solution? The answer, we suspect, is complicated, and ironically not why you might think.

Overclocking has always been a unique pastime, given that it's dependent on how lucky you are with your processor. The silicon lottery ensures that each processor will behave differently. AI overclocking takes advantage of that by looking at patterns of similar processors and then dialing in settings that "should" work with those chips and conditions. But from a consumer standpoint, that performance delta could be anything from a 200 MHz overclock to a 1000 MHz overclock on the top-end.

The problem is advertising standards. How can you sell a product that will operate at one frequency for Steve, but at another for Richard? You could get around that with tighter binning on initial manufacturing, but the waste on that could potentially be huge. How do you define those ranges? See the problem? It's better to have a one-button solution that the user 'opts in' to, and avoids the problems entirely.

WHAT IS AMD DOING?



Interestingly, AMD is in a bit of a unique position where it currently has market dominance, and a whole swathe of processors in its arsenal to counter Intel. There is, however, an argument to be had as to whether that's a good or bad thing. On the one hand, Team Red has a swathe of processors perfectly suited to any task. Only care about gaming? Get an X3D processor. Want something that delivers the best performance in multi-threaded workloads? Get a standard X series processor instead. Looking for a computational powerhouse that will give you the best enterprise-level performance? A Threadripper chip is the way to go.

The only problem is that each one of those has its drawbacks compared to Intel's offerings. The X3D processor might have a massive cache for epic gaming performance, but it can't keep up in multi-threaded tasks. That traditional X series? Has the edge in multi-threaded tasks, but won't cut the mustard in-game. The Threadripper processor may be dominant in professional-level tasks, but is just too slow for day-to-day usage.

Weirdly, by being just 'good', Intel's processors offer some of the best versatility money can buy, and that's no bad thing.

That's not to say AMD is out of the count. Rumors have it that it's going to be launching its 8000 series processors in Q2 2024 on the new Zen 5 architecture. There's even a number of screenshots purporting up to 16 cores and a massive L-cache—sort of a hybridization of its X3D and X series chips. If that's the case, Intel needs to be looking at its own belly button, because that could easily supplant Team Blue in pretty much every arena.

Generational differences

14th gen has been a bit all over the place. There are some interesting computing developments, particularly with APO and the AI overclocking, but the fact that it's random or limited to the Core i9 and Core i7 models makes it feel a touch sloppy.

Again, the architecture is solid, but it's not exactly any different to the 13th-generation chips. It's a refinement in the manufacturing process, rather than new. This begs the question: should you wait for the 15th gen and Arrow Lake, or jump ship to this generation of processors?

We'll list below the differences (if any) between the generational chips, but the long and the short of it is that unless you're grabbing a Core i9 for its APO compatibility, or a Core i7 for its improved E-Core numbers, you're probably better off trying to pick up a deal on the last-gen 13th series chips instead.

INTEL 14TH VS 13TH GEN

	Core i9 14900K / Core i9-13900K	Core i7 14700K / Core i7-13700K	Core i5 14600K / Core i5 13600K
P Cores / Threads	8 (16) / 8 (16)	8 (16) / 8 (16)	6 (12) / 6 (12)
P Cores Turbo Boost Max	6.0 GHz* / 5.7 GHz	5.6 GHz / 5.4 GHz	5.3 GHz / 5.1 GHz
E Cores / Threads	16 (16) / 16 (16)	12 (12) / 8 (8)	8 (8) / 8 (8)
E Cores Turbo Boost Max	4.4 GHz / 4.3 GHz	4.3 GHz / 4.2 GHz	4.0 GHz / 3.9 GHz
Smart Cache	36 MB / 36 MB	33 MB / 30 MB	24 MB / 24 MB
Base Power	125 W / 125 W	125 W / 125 W	125 W / 125 W
Max Power	253 W / 253 W	253W / 253 W	181 W / 181 W
RRP	$589 / $589	$409 / $409	$319 / $319

*Core i9-14900K features TVB (thermal velocity boost) under the correct cooling conditions it will hit 6 GHz, otherwise standard Turbo Boost 3.0 leads to 5.8 GHz max frequency on performance cores. This is identical to the Core i9-13900KS. RRP correct at the time of publishing.

GEAR of the YEAR

There were more high-scoring products than ever in 2023. Here's the best of the best

HOW TO SUM UP 2023's hardware highlights? It definitely wasn't the year of the GPU. Every graphics card this year has either been a bit disappointing or a lot overpriced. Storage tech hasn't exactly blown us away in 2023, either. Sure, you can now buy a PCIe Gen 5 drive, but while the peak numbers look amazing, more nuanced metrics of storage performance, like random access, aren't all that. And what's with the Gen 5 drives needing active cooling?

The CPU side of the equation has been a bit better, especially thanks to AMD's nifty X3D chips with gaming-friendly 3D V-cache. However, we'll have to wait for late next year for something really compelling from Intel. Screen technology took a huge step forward, too, and not just with the arrival of a critical mass of OLED options. Samsung also moved the game on—for those who can afford it—with the first dual-4K gaming panel. It's stunning.

We've seen some very nice new peripherals too, with the best gaming keyboard for years, an outstanding mouse, and a fantastic set of cans. But if you demand true novelty in 2023, it has to be the new breed of handheld gaming PCs powered by AMD's amazing Phoenix APU. Even a few years ago, devices like the OneXPlayer OneXFly simply would not have seemed possible.

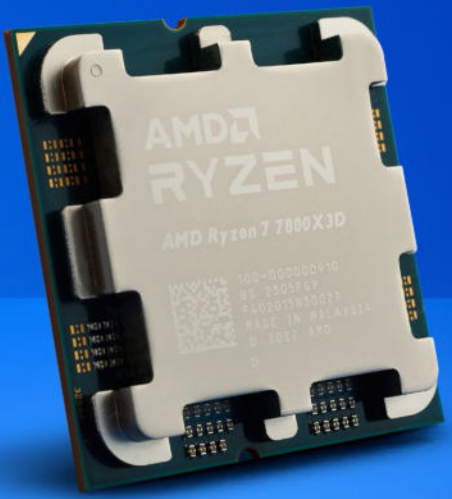
SPECIAL MENTION

ONEXPLAYER ONEXFLY

2023 has undoubtedly been the year of the handheld gaming PC. Sure, Valve got there first with the Steam Deck last year, but AMD's Phoenix APU moved the game on massively and literally in terms of performance, giving birth to an army of new devices. Our favorite of the bunch is the OneXPlayer OneXFly. It's smaller than most, but its 7-inch screen is still a 1080p beauty. It even has a slimmer bezel than the competition, only increasing its size advantage, and it achieves that with absolutely no performance disadvantage. The downside? It's not cheap.

- **$739-1,299, www.onexplayerstore.com**
- **Reviewed: Maximum PC, November 2023**

CPU



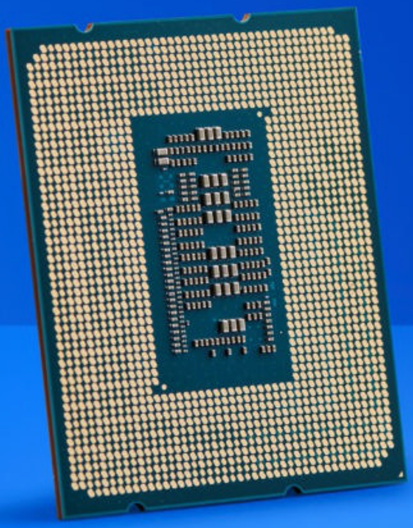
AMD RYZEN 7 7800X3D

AMD has gone and done it again. The Ryzen 7 7800X3D is a gaming masterpiece. It's also by far the most appealing of its latest 3D V-cache. Its more expensive siblings have a slightly odd asymmetric architecture, but the 7800X3D has just a single eight-core CPU die with a 64MB lump of sweet game-accelerating V-cache. It's not even ridiculously expensive, and can currently be had for about $370. That's already way down from its $450 launch price.

- $370, www.amd.com
- Reviewed: Maximum PC, June 2023

★★★★★

CPU



INTEL CORE i5 13400F

Unlike GPUs, which remain painfully pricey, excellent CPUs can be had for sensible money. For proof, look no further than the Intel Core i5 13400F. Yours for a whiff under $200, it gives you six Performance cores and four Efficient cores. That makes for an excellent overall compromise. The big boy cores ensure outstanding gaming grunt, while the extra Efficient cores add a helpful dose of multithreading throughput. Only a lack of overclocking support detracts from an otherwise superb CPU.

- $196, www.intel.com
- Reviewed: Maximum PC, July 2023

★★★★½

GPU

NVIDIA GEFORCE RTX 4070

An Nvidia GeForce RTX 3080 for $100 less—that's the easiest way to think of the new RTX 4070. It mostly matches its older, higher-positioned sibling, but comes in at $100 lower in terms of MSRP. Happily, the 4070 has gotten even cheaper since launch. We've seen one as low as $540 on Newegg. For that, you get all the usual RTX 40 goodies, including DLSS, Frame Generation, and Ray Reconstruction. The only slight worry is the 192-bit memory bus and 12GB of VRAM.

- $550, www.nvidia.com
- Reviewed: Maximum PC, June 2023

★★★★

GPU

AMD RADEON RX 7800 XT

AMD's new upper mid-tier GPU doesn't do anything radical. It's a bit more expensive than we'd like, but in the reality that is expensive graphics cards, this a compelling option at the $500 price point. It pretty much blows away the Nvidia RTX 4070 when it comes to traditional raster performance, which is most games, most of the time. The relatively poor support for ray tracing continues to disappoint, and Nvidia's fancy features are beguiling, but for proper gaming, this is an excellent card.

- $500, www.amd.com
- Reviewed: Maximum PC, November 2023

★★★★

MONITOR

ALIENWARE 34 AW3423DWF

At last, the OLED revolution has arrived on the PC. Alienware's second OLED panel is very similar to its first, so it's still a 3,440 x 1,440 item based on Samsung QD-OLED tech—it just runs at 165Hz instead of 175Hz, and loses the pointless G-Sync chip. If that hardly matters, this 'F' model's glossy coating makes all the difference. It really lets the OLED panel sing. The HDR performance and contrast are ridiculous. The one small worry is the risk of burn in, but you do get a solid three-year warranty.

- **$999, www.alienware.com**
- **Reviewed: Maximum PC, August 2023**

★★★★

MONITOR

SAMSUNG ODYSSEY NEO G9 G95NC

If 2023 was the year OLED hit critical mass on the PC, there was one other monitor milestone. Give it up for the Samsung Odyssey Neo G9 G95NC. This 57-inch masterpiece amounts to two 4K monitors fused together. Despite that double-4K native res, it still hits 240Hz. Good luck finding a GPU to drive it that fast. Still, the G95NC boasts improved mini-LED local dimming with 2,392 zones and none of the clunkiness suffered by previous Samsung panels.

- **$2,499, www.samsung.com**
- **Reviewed: Maximum PC, December 2023**

★★★★½

LAPTOP

LENOVO YOGA SLIM 9i

14-inch 2.8K OLED screen? Check. 14-core Intel CPU? Yup. Zippy SSD, 16GB of RAM, and three Thunderbolt 4 ports? You bet. The Lenovo Yoga Slim 9i really does pack an awful lot into its ultra-slim chassis. Heck, that OLED panel even runs at 90Hz. Okay, this is certainly no gaming beast—it only has integrated graphics. But in truth, it's not that kind of machine. Instead, it gives you nearly 12 hours of battery life, a lovely big trackpad, fabulous build quality, and even half-decent speakers. All in all, it's a fantastic little machine.

- $1,499, www.lenovo.com
- Reviewed: Maximum PC, March 2023

★★★★½

LAPTOP

FRAMEWORK 13 AMD MAINBOARD

We already loved Framework's stupidly clever, fully upgradeable laptop. Now, it has been given the upgrade it was crying out for in the form of a new AMD mainboard, boasting the awesome Phoenix APU. Yep, the same chip found in the new breed of gaming handhelds, including the OneXPlayer OneXFly. It's not cheap at $699, but it does transform the Framework 13 into a fantastic all-rounder, with reasonable gaming performance, outstanding multi-threading, and even better battery life.

- $699, www.frame.work
- Reviewed: Maximum PC, Holiday 2023

★★★★½

SSD

SOLIDIGM P44 PRO 2TB

SOLIDIGM
P44 Pro
PCIe 4.0 NVMe M.2 SSD

The SK Hynix Platinum P41 earned our admiration in late 2022, so hopes were high for this respin using the more consumer-facing Solidigm brand. We weren't disappointed. This is a very high-spec PCIe 4 drive, with SK Hynix's excellent Aries controller chip and 2GB of DRAM cache. It's very much up there with the SK Hynix Platinum P41 and other leading Gen 4 drives, including the WD Black SN850X and Samsung 990 Pro. But it's cheaper than the P41, and comes with extra software. Enough said.

- $142, www.solidigm.com
- Reviewed: Maximum PC, February 2023

★★★★½

SSD

LEXAR NM790 1TB

PCIe Gen 5 drives have arrived. But while peak speeds are up dramatically, the latest drives aren't a huge step in other areas, like latency and random access. That's why a value PCIe Gen 4 drive like the Lexar NM790 still makes a lot of sense. Performance wise, it's usually on a par with other high-spec Gen 4 drives, but this 1TB model can be had for just $70. To achieve this price, it uses the lesser-known Maxio MAP1602 controller, and doesn't have any DRAM cache at all. All in all, it's very impressive for the money.

- $70, www.lexar.com
- Reviewed: Maximum PC, September 2023

★★★★½

790
Lexar
NM790
M.2 2280 PCIe Gen4x4 NVMe SSD

MOUSE

LOGITECH PRO X SUPERLIGHT 2

You might think that at just 60 grams—three grams lighter than the original model—the Logitech Pro X Superlight 2 is all about weight. Actually, there's way more to this mouse—it's just all the goodness is super-light. The DPI and polling rates are up, the battery life is increased, and the microUSB connection has been ditched in favor of USB-C. So don't be fooled by the plain exterior; this super-light, uber-responsive, and remarkably long-lasting mouse has it all going on under the skin.

- **$159, www.logitech.com**
- **Reviewed: Maximum PC, December 2023**

★★★★½

MOUSE

STEELSERIES AEROX 5 WIRELESS

A $140 mouse comes with lofty expectations. Happily, he Aero 5 delivers. It's lightweight, has great build quality despite that, stats that speak for themselves, long battery life, plenty of customization, and even features IP54 protection from dust, dirt, and oil. Just as important, it's ultra-low latency, and feels extremely snappy and accurate, and therefore much like using a wired mouse, just without the cable annoyances. Ultimately, this is exactly what you want from a wireless rodent.

- **$140, www.steelseries.com**
- **Reviewed: Maximum PC, January 2023**

★★★★

KEYBOARD

ASUS ROG STRIX SCOPE II 96 WIRELESS

Building off the back of the Asus ROG Azoth, this is simply the best new gaming keyboard in years. For starters, it boasts factory lubed switches. It makes all the difference, as each key drops lightly into place and smoothly springs back with a well-oiled clack. The RGB lighting is massively configurable, too, and the battery life is also decent. Downsides are hard to pick, but the slightly reduced proportions result in a delete key squished up into an unusual position. Not exactly a deal breaker, is it?

- $180, www.asus.com
- Reviewed: Maximum PC, November 2023

★★★★½

KEYBOARD

CORSAIR K70 MAX

Is this the fastest keyboard ever? Every key in the K70 MAX is fitted with one of Corsair's fancy MGX Hall Effect switches, tapping into that magnetic-mechanical magic. They can be set to actuate at just 0.4mm of travel—much snappier than MX Speed switches. That's not ideal for ignoring accidental keystrokes when typing, but if you're playing online shooters, where the smallest of split seconds count for everything, it's a potential winner.

- $230, www.corsair.com
- Reviewed: Maximum PC, December 2023

★★★★

HEADPHONES

STEELSERIES ARCTIS NOVA PRO

A lot of money for some gaming cans? Yep, but the SteelSeries Arctis Nova Pro does come bundled with the SteelSeries GameDAC Gen 2, with its anodized volume dial and 8-bit OLED display. These headphones are designed for a persistent desktop setting rather than listening on the move, and boy do they deliver punchy, atmospheric audio when using the included DAC. With this in mind, we can definitely forgive the lack of wireless connectivity—it's just not what these headphones are about.

- $250, www.steelseries.com
- Reviewed: Maximum PC, February 2023

★★★★★

HEADPHONES

CORSAIR HS65 SURROUND WIRELESS

Is wireless worth the extra wedge? A perennial headset conundrum, but in this case the answer is yes. The wired variant goes for $80 and offers impressive and encapsulating surround sound. This wire cutter upgrade gives you on-the-fly controls, great battery life, and all the auditory perks of the original. Plus, the wireless performance is excellent thanks to low-latency 2.4GHz tech with the option of Bluetooth 5.2. The latter offers an extremely expansive range of up to 50 feet.

- $120, www.corsair.com
- Reviewed: Maximum PC, March 2023

★★★★½

© CORSAIR

HANDHELD GAMING PC

ASUS ROG ALLY

While we probably have the Steam Deck to thank for both the Asus ROG Ally's very existence and its relatively affordable price, it's AMD who has made it technically possible thanks to its stunning Phoenix APU, branded here as the Z1 Extreme. It gives the Ally gaming performance significantly beyond that of the Deck, and without a massive price premium over the equivalent Valve model. In short, the ROG Ally is a fast, responsive, good-looking gaming PC on the go.

- $699, www.asus.com
- Reviewed: Maximum PC, August 2023

★★★★½

HANDHELD GAMING PC

AYANEO AIR 1S

If being portable ought to be what a handheld PC is all about, then the Ayaneo Air 1S is doing it better than most. This thing is incredibly small—in fact, it's smaller than a Nintendo Switch—but somehow it comes with the same incredible AMD Phoenix APU as the much bigger ROG Ally. And yes, it's the full Phoenix chip with all 12 graphics CUs. The small size does cap performance a little due to limited thermal capacity, but the real problem is price. At over $1,000, this is one pricey pocket PC.

- $1,029, www.ayaneo.com
- Reviewed: Maximum PC, December 2023

★★★★

MOTHERBOARD

MSI Z790I EDGE WI-FI MINI-ITX

This MSI board offers one of the best chipsets around, has great support for DDR5, features lightning-fast PCIe Gen 5 support for SSDs, a surprising number of ports, great connectivity and is well built to boot. Oh, and it does all that within the tiny confines of the mini-ITX form factor. Nice. The only slight issues are an ugly Wi-Fi antennae and an unsophisticated debugging solution, not to mention the high price. But if you're considering a small form factor build, this is a brilliant choice.

- $349, www.msi.com
- Reviewed: Maximum PC, August 2023

★★★★½

MOTHERBOARD

ASUS ROG STRIX B650-A GAMING WIFI

The cheapest of the Asus Strix family for the AM5 socket, the Asus ROG Strix B650-A Gaming WiFi isn't exactly a bargain, especially for a B650 rather than X670E board. But the B650 chipset still supports the latest AMD Ryzen 7000 chips, DDR5 and PCie 5.0. It's no slouch. You also get Wi-Fi 6E and an antennae, nifty clip-down M.2 slots that don't require screws, plenty of ports on the back panel, and nice build quality. Silly gaming-inspired logos dotted about the board aside, there's very little not to like.

- $280, www.asus.com
- Reviewed: Maximum PC, February 2023

★★★★

PROJECTOR

XGIMI HORIZON ULTRA

Relatively unknown just a few years ago, XGIMI has carved out quite the niche when it comes to projectors. It just keeps knocking it out of the park. Its latest home run is the Horizon Ultra, a hybrid laser and LED short-throw beamer with full 4K resolution and low latency for gaming. Its main selling point is Dolby Vision integration, and thus great HDR performance. Movies and games really pop. The only downside is no native Netflix support. XGIMI's workaround is limited to 1080p, sadly.

- $1,700, www.xgimi.com
- Reviewed: Maximum PC, November 2023

★★★★½

4K
harman/kardon

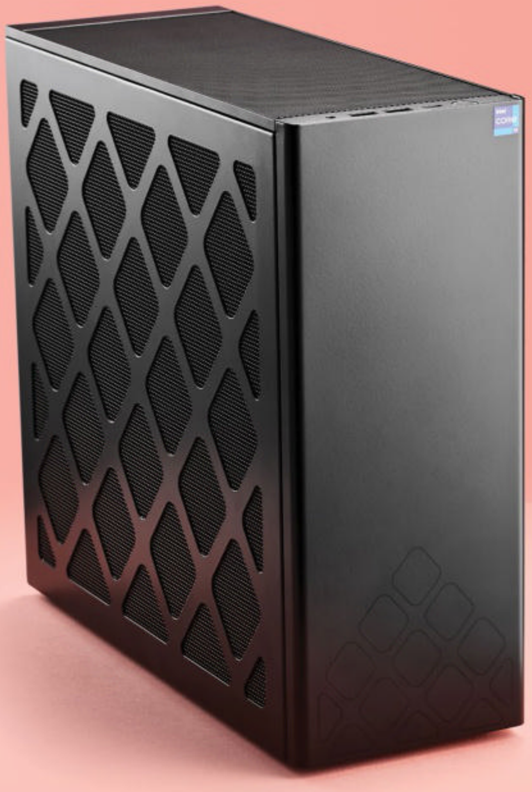
MINI PC

INTEL NUC 13 EXTREME RAPTOR CANYON

We prefer to build our own full-size tower rigs here on MPC, but with pint-sized PCs, at least partial pre-built is often the way to go. Intel may have called time on its own NUC mini PC project. This makes for one heck of a last gasp, with its Core i9-13900K monster CPU and space for triple-slot GPUs up to 317mm thick. The PSU has also been upgraded to 750W, so there's just enough space and power for an Nvidia RTX 4080. The only problem is the cost, even with a graphics card.

- $1,599, www.intel.com
- Reviewed: Maximum PC, March 2023

★★★★



VR HEADSET

META QUEST 3

As a simple VR package, the Quest 3 strikes an excellent balance between performance, comfort, and price. Easy to set up, comfy to use, and offering good image quality and low latency, it proves that you don't have to take a kitchen sink approach, especially for the casual VR gamer.

Meta itself has yet to prove that its broader idea of mixed reality as a life-changing application is truly compelling. But for the relatively simple task of playing games, the new Quest 3 definitely delivers.

- $500, www.meta.com
- Reviewed: Maximum PC, Holiday 2023

★★★★½

© META

SURROUND SPEAKERS

STEELSERIES ARENA 9

This is SteelSeries' best speaker system, and it comes at quite a price. Thankfully, it also delivers quite an experience. These speakers produce a vast soundscape, with highs that sit above a well resolved midrange and punchy bass that doesn't overwhelm the sound. Oh, and it all operates over a single USB interface. Add neat RGB lighting and a slick OLED control panel with retro 8-bit graphics, and you have a compelling package.

- $550, www.steelseries.com
- Reviewed: Maximum PC, July 2023

★★★★½

steelseries

CASE

NZXT H9 FLOW

We already loved NZXT's H7 range of cases. The H9 Flow is even better. It's deeper, wider, taller, and sports dual glass panels. The latter allows for a unique level of through-case transparency, and makes for a fabulous aesthetic vibe, although you'll have to be on your game when it comes to cable management, as it's all on show with the H9 Flow. Still, that's easily done, as there's tons of space inside, super-ergonomic design, and excellent build quality. The only missing feature? There's no RGB lighting as standard.

- $160, www.nzxt.com
- Reviewed: Maximum PC, April 2023

★★★★★

CASE

BE QUIET! SHADOW BASE 800 FX

Most cases come in $50—over $100 cheaper than this premium priced Be Quiet! Box. What are you getting for the extra cash? Brilliant build quality, for starters. Then there's ease of use. The panels can be pulled off with minimal effort, and the routing for cables and connectors is very well thought out. The airflow is well managed, too, with locating points for eight blows, plus no fewer than three water rads. Of course, it looks great, too, thanks to slick styling and subtle RGB accents.

- $200, www.bequiet.com
- Reviewed: Maximum PC, Holiday 2023

★★★★½

GAMING CHAIR

CORSAIR TC100 RELAXED

A relaxed gaming chair for a chilled price? That'll be the Corsair TC100 Relaxed. Corsair's T3 Rush already had us won over at $320, but this even cheaper option makes surprisingly few compromises to hit a lower price point. You still get a thick cushion, broad design, and refined styling, along with a choice of fabric or leatherette covers. The major downside are the 2D armrests with reduced adjustability versus the T3 Rush. That aside, this is a very comfy chair at a great price.

- $250, www.corsair.com
- Reviewed: Maximum PC, September 2023

★★★★½

VIDEO CAPTURE

AVERMEDIA LIVE GAMER ULTRA 2.1

Welcome to the first mainstream video capture device that supports HDMI 2.1, albeit only in passthrough and without 8K capture. The point is that you can hook this thing up in between your PC and a monitor without losing HDMI 2.1 output to the latter. Anyway, in capture terms, 4K is plenty. Hardly anyone has the means to playback 8K. The box itself is nicely made, and the HDMI 2.1 support means you can capture gaming content at high frame rates, including 4K@144Hz.

- $300, www.avermedia.com
- Reviewed: Maximum PC, Holiday 2023

★★★★

HOMEBREW PC ALTERNATIVE

RASPBERRY PI 5

Now in its fifth iteration, the Rasberry Pi has come a long way, transitioning from pure text interfaces to now being able to run Windows, if you ask nicely enough. Pi 5 offers three times the processing power of Pi 4, thanks to a quad-core Arm CPU, comes with 8GB of RAM, and can even support an NVMe SSD, albeit running at PCIe 2 speeds. It's a crazy amount of computing for so little money. The only minor snag is the higher power requirement, so Pi fans may need a new PSU.

- $80, www.raspberrypi.com
- Reviewed: Maximum PC, Holiday 2023

★★★★½

WI-FI DONGLE

NETGEAR NIGHTHAWK A8000

If you've upgraded your router or mesh system to Wi-Fi 6E, but your desktop or laptop lacks support, say hello to the Netgear Nighthawk A8000. It's essentially a glorified Wi-Fi dongle that's built for speed. It's pretty big for a dongle, thanks to a beefy antennae, but you have the option of using the bundled dock, which connects via a wire. Performance is better than most integrated receivers, and there's a Wi-Fi 7 version coming, too. The only negative is that it's USB-A, there's no USB-C version for now.

- $90, www.netgear.com
- Reviewed: Maximum PC, August 2023

★★★★

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BEST OF IFA 2023

What were the biggest releases and announcements from this year's European showcase of all things tech? Tim Danton trawled Berlin Messe's many halls to find out

AT THE START of September this year, almost 200,000 people descended upon Berlin for the world's biggest trade show dedicated to consumer electronics and home appliances: IFA. It's a show with a long and glistening history, too. This is where Philips unveiled the CD, Telefunken the first widely available TV sets, and Sony the world's first video cassette player.

Unless we somehow missed it, nothing to match the importance of those releases happened at this year's show, which celebrates its 100th anniversary next year, but it was a bustling event—one that suggests trade shows are on their way back to full health after three difficult years because of Covid.

Here, we pick out the key trends from the showfloor, and give our thoughts on the products that caught our eye.

A SUSTAINABLE FUTURE?

IFA'S SHOW ORGANIZERS made much of sustainability at this year's show. It isn't just posturing: according to Oliver Merlin, IFA's managing director, this is a response to consumer demand. "I would say, even only a year or so ago, sustainability was at maybe number four, number five [in reasons to buy a product], right behind the price, behind the brand, behind the quality of the product," he said at the show's opening press conference. "Now, sustainability is one or two."

That was based on data from IFA's partner, consumer research specialists GfK, and was no doubt one of the reasons that the show created an area dedicated to sustainability for the first time. Called the Sustainability Village, it contained a handful of companies with the 'S' word at their heart, along with an area for speakers. These included Fairphone, whose employees gave practical demonstrations on how to upgrade phones. We attended one session on how robots could help to make industry more sustainable, rather than being a drain on components and minerals.

Would we have liked to see a bigger Sustainability Village, packed to the hilt with companies that put environmental considerations first? Yes, absolutely. But even though only Ambient Photonics made our cut for this feature, we saw many companies around the halls that were doing great things.

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2.2x More Power

AMBIENT PHOTONICS

Even if Ambient Photonics becomes huge, you will never hear the company's name. That's because it creates solar panel technology rather than the final products; and who knows the name of the company that supplies those tiny panels that power calculators? There are two things that mark Ambient out from the norm. First, its panels are three or four times more

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effective than the incumbent tech. The second is that one of its key backers is Amazon.

We suspect that its products will be tucked within keyboards, mice, and other accessories in months rather than years. If that means less reliance on batteries and mains power—cutting down the clutter of cables in the process—then it has to be progress.

HUNE

A five-minute walk from the Sustainability Village, tucked into a corner of one of the many halls apparently dedicated to purveyors of off-grid power supplies, we ran into Hune. This company, based in Argentina and Italy, puts sustainability and transparency at the heart of what it does, right down to publishing an impact report for every product it produces.

So far, that includes chargers, earphones, cables, and a speaker, but don't be alarmed if you visit hune.eco and see prices in the hundreds of dollars. Those are Mexican pesos, and the Mex$399 it charges for earphones equates to around $24. Its upcoming Fauna headphones, complete with active noise canceling, will cost around $60—if Hune gets a distributor in the UK, and we hope it does.

FIXFIRST

With so much space, it was perhaps a missed opportunity to tuck environment-friendly companies such as FixFirst into the IFA Next area. There, we found Sebastian Daus, co-founder and CEO of fixfirst.io, to talk about their mission: "We want to make the repairing and circularity of products easy," he told us.

His main weapon is a software platform, "an Airbnb for repair". This oversimplifies what the company offers, though, which includes an AI tool that can help support staff identify faults and fixes, a remote video service, and an accelerator programme to help companies think in a more circular fashion. Daus said FixFirst is already working with "bigger brands in the electronic space and retailers".

BELKIN

As we chatted about its trio of new 15W Qi2 BoostCharge chargers, its spokesperson mentioned that not only will all of its new products be built from as much post-consumer recycled plastic as possible, but that it is also updating its most popular designs to use PCR instead of virgin plastic (something Belkin announced at CES, but we missed at the time). Every little helps.

FAIRPHONE 5

During his announcement of the Honor Magic V2 phone, Honor's CEO, George Zhao, mentioned that phones have become boring. He's right. While Honor's approach is to produce one of the most unrepairable phones ever, Fairphone is going in the opposite direction with the Fairphone 5. You can repair almost every component that can go wrong: the battery, its all-new OLED screen, the USB-C port, the speakers, and the trio of cameras.

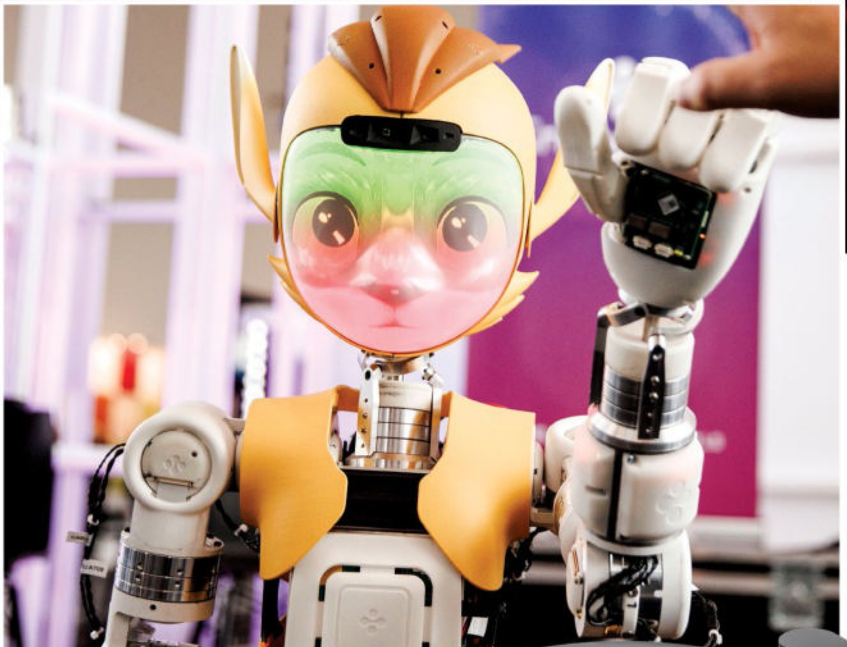
Fairphone backs this up with a five-year warranty, says it will support Android updates during that time, and aims to keep support running for ten years. You can order the Fairphone 5 now, albeit at a higher price of $699, compared to $599 for the Fairphone 4.

ROBOTS

SOME OPTIMISTS—you could even call them pessimists—think that robots are going to be everywhere within ten years, helping out in care homes and hospitals, driving our cars, performing operations. But if IFA 2023 is anything to go by then we have many problems to solve.

Yes, some robots are well developed. Dozens of stands, from the glossy to the ramshackle, offered robot vacuum cleaners, a handful showcased robot mowers, and we wandered past one robot cleaning windows. Sadly, the latter was more like a vertical robot vacuum cleaner than anything Isaac Asimov wrote about.

But there are signs of more intelligent, general-purpose robots. Read on to discover what makes Desdemona special, and how a French company is indeed hoping to support carers with a helper on wheels.



DESDEMONA

The idea behind Desdemona, making her European debut at IFA 2023? To become the world's first robot celebrity, the makers claim. Clearly they've never heard of Max Headroom. But where Max's wordplay was scripted, Desdemona is powered by SingularityNet's artificial intelligence, and can engage in fluent conversation with you in virtually any language. She has the added advantage of being able to sing, and unlike most pop stars, her range and talents are theoretically unbounded.

Up close, there's still something weird about humanoid robots, especially when Desi (as she's called) turns her head towards you as you attract her attention.

Desdemona is the result of a partnership with Hanson Robotics, which gained plenty of fame as the "world's first robot citizen". According to the joint venture's creative director, Ben Ditto, who we spoke to at the show, they think of Desdemona as Sophia's little sister.

ENCHANTED TOOLS

While humanoid robots with semi-realistic skin can creep people out, Enchanted Tools has taken a different approach: its robot helpers have cartoon-like faces, and navigate via giant rollers. Just like Desdemona, however, they're at the prototype stage, with actual robots not going on sale until 2025—and for a cost of around $32,000.

They're designed for hospitals, care homes, hotels, and restaurants, and we were told they've gone down well with older patients. Enchanted Tools is French, and it expects the first rollout to be in Parisian hospitals, but if all goes well then the rest of Europe will follow.

Unlike Desdemona, we would actually welcome these robots, not least because they had a humorous habit of wandering away from their owners, which meant the CEO had to cling on to his charge during a TV interview we gatecrashed.

ROBOROCK Q5 PRO

Of the companies that make robot vacuum cleaners, Roborock has emerged to be one of the market leaders. It announced two more in its already extensive lineup at IFA (along with a washer-dryer that cleared its own lint): the deluxe Q8 Max with object avoidance for €499 ($530), and the more basic but affordable Q5 Pro for €349 ($370). But this isn't really a basic model, with a clever dual brush to pick up fur matched with the option for automatic emptying, so you only have to empty the bin every couple of months. This may not be robots as science-fiction writers intended, but we still like them.

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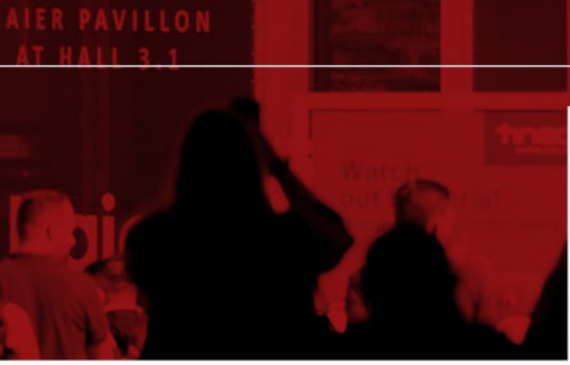


LG Smart Cottage

AN OUTDOOR LIFE

IF WE NEVER SEE an off-grid power supply again, it will be too soon. At one point, it felt like every stand we passed offered variants on the same thing: a cuboid box of varying size powered by as big a battery that could fit inside. You then simply plug in your devices of choice and start working.

There were two main problems being addressed. One was the increasing number of blackouts and brownouts happening around the world. The second was a trend towards outdoors living, particularly camping. It turns out people really can't live without access to electricity anymore.

URBANISTA MALIBU

It may take decades to fully switch from carbon-based fuel sources for our homes and offices, but there's nothing to stop us switching to solar power for peripherals. Urbanista already produces solar-powered headphones and earphones, and at IFA it announced the Malibu outdoor speaker.

This outputs 2 x 10W audio and comes with IP67 protection against rain for when the solar panel integrated into its top isn't soaking up the sun. It is on sale for $149. For updates, go to urbanista.com/pages/malibu.

LG STANBYME GO

Perhaps the one thing that's been stopping you from camping is the prospect of not being able to watch TV? Well, rejoice, because LG has solved the problem via a TV-in-a-briefcase.

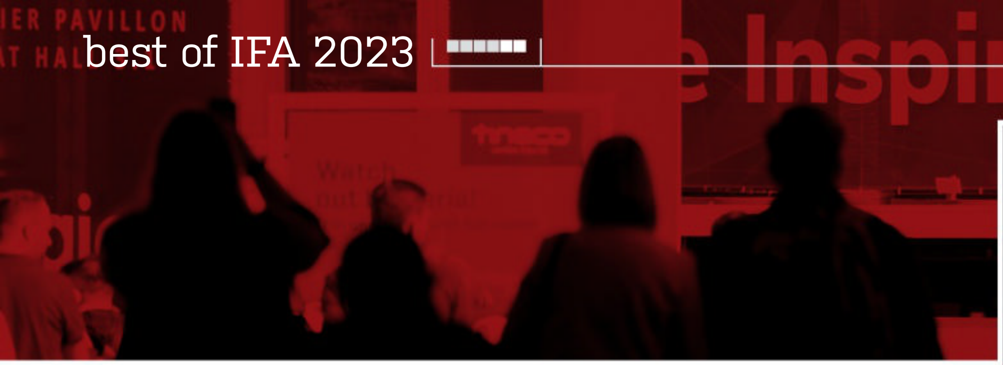
At heart it's a 27in 1,920 x 1,080 IPS display, so can be used as a normal screen, but LG is working with partners such as Apple, Amazon, and Disney to give that out-of-suitcase smart TV experience. You can also stream Spotify via four built-in speakers. It's heavy thanks to a battery that can keep the TV going for three hours.

The StanbyME Go is available in South Korea and on pre-order in the US for $999.

JACKERY SOLAR GENERATOR 300 PLUS

Two things makes Jackery's off-grid power supplies stand out. One is the design of the chargers, with an orange flash that breaks up the monotony of what would otherwise be a dull, gray box. The second is the maturity of its solar panels, which can charge the all-new Solar Generator 300 Plus in four hours if you buy the 100W solar charger.

The 300 Plus is designed for camping in particular, and at 5kg it's carryable. With a capacity of 288Wh, and output of 300W, it can recharge a laptop up to three times and a phone 13 times. It's available from $399.



PHONES AND WATCHES

IFA 2023 isn't the main launchpad for phones and tablets; that's Mobile World Congress in Barcelona in February. However, we do see some offbeat launches, and this year was no different.

HONOR V PURSE

The V Purse was announced by Honor's CEO, George Zhao. It uses a similar design to the Huawei Mate Xs 2, with the screen folding on the outside of the phone rather than inside. Now, Honor has added a twist by turning it into a purse. Kind of.

There are three key differences with to the Huawei phone. One, is interchangeable straps so it can be carried. Two, a bunch screens that can flow with you as you walk. Three, it runs Android rather than Huawei's custom OS.

Just as we were going to press, Honor announced that the Purse could be pre-ordered in China for 5,999 yuan (around $820).

WITHINGS SCANWATCH 2

It's hard not to like Withings' take. It looks good, lasts for weeks on a charge, and has a low-profile design.

The ScanWatch 2 doubles down on health sensors, with the headline feature being skin temperature measurement. Changes here could give you an early sign of underlying issues. There's also an ECG module, SpO2 monitoring, and all the usual sensors. It's available now for $350.

TCL 40 NXTPAPER

With virtually no fanfare, TCL launched the 40 Nxtpaper smartphone series at IFA 2023.

Rather than using IPS or OLED displays, these phones feature a 6.8in Nxtpaper display that's almost paper-like to touch and easy on the eyes. The display doesn't have the rich colours of a normal phone, but we would far rather read long documents on this than our normal phone. You can switch to mono mode if you prefer, too.

HONOR MAGIC V2

We already knew about the Magic V2; it was launched in China in July. But IFA 2023 was the first time we had seen it in the flesh. The first thing that strikes you is its slimness; as Honor CEO George Zhao put it, we have entered the "millimeter era" for foldables. The Magic V2 fits neatly into a jeans pocket in the way the Fold5 simply can't.

The rest of the phone is predictable enough, with a trio of high-spec "rear" cameras, a narrow front screen, and Qualcomm's latest chipset in charge. The only surprise is that Honor manages to squeeze in a 5,000mAh battery, claiming to outlast the iPhone 14 Pro even if you use the main, unfolded screen.

In China, the base model sells for 9,000 yuan (roughly $1,230), but we expect it to be higher than that when it goes on sale. Also, the Magic V2 looks tough to repair, which doesn't fit with the sustainability trend.

A CREATIVE LIFE

IFA isn't a show geared towards creative professionals, but two launches might just have your credit card twitching…

LENOVO THINKVISION 27 3D MONITOR

First, the bad news. This glasses-free 3D monitor won't be available until February 2024. Nor will it be cheap, with Lenovo stating a price of €2,499 ($2,635). The good news is that we suspect it will be worth both the wait and the price.

Acer has shown how effective glasses-free 3D tech is with its SpatialLabs View and View Pro displays (see issue 344, p58), but those were 15.6in portable screens. When viewing 3D models, the more space the better, and Lenovo implements it brilliantly. The technology works via eye-tracking cameras and a lenticular lens on the panel. This adjusts to send one pixel to your left eye, the other to the right, turning a 2D 4K display

© HONOR, WITHINGS, TCL.

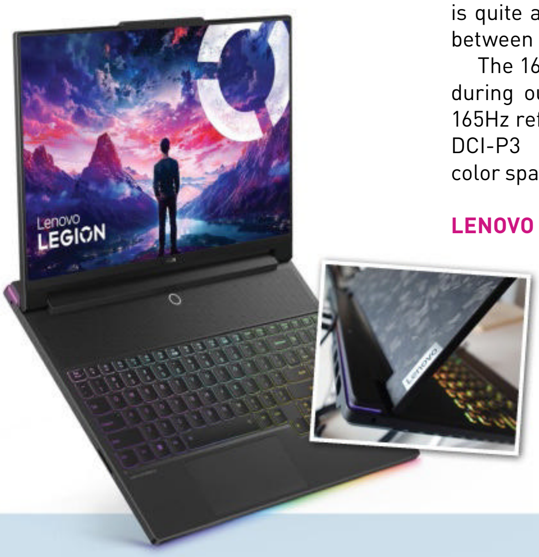
AIER PAVILLON
AT HALL 3.1
e Inspired
Lenovo
LEGION

LAPTOPS & PCS

ANYONE HOPING to catch sight of exciting new laptops at IFA 2023 would have been disappointed. MSI displayed its Commercial 14 laptop, but that was launched at Computex in Taiwan in May; the most interesting action was happening away from the showfloor in a private event hosted by Lenovo nearby. Fortunately, we were invited to take a look.

LENOVO LEGION 9I

If you're only going to release one laptop at IFA, you might as well make it a corker. That certainly seems to be Lenovo's thinking, as it has packed the Legion 9i with its own liquid cooling system.



That isn't merely for show. It means that it can supply even more power to the Intel Core i9-13980HX processor and GeForce RTX graphics: you can choose between an RTX 4080 or an RTX 4090 when it goes on sale at some point, we hope, in October. Lenovo says the design means it can deliver 230W of total power to the GPU/CPU combo, which is quite a feat in a laptop that measures between 18.9mm and 22.9mm deep.

The 16in mini-LED also looked superb during our play with the device, with a 165Hz refresh rate and a choice between DCI-P3 and sRGB factory-calibrated color spaces.

LENOVO LEGION GO

There was a positive swagger to Lenovo's staff as they talked through the Legion Go at its pre-IFA launch. This is a rival to the Asus ROG Ally and Steam Deck, and while both those portable gaming devices have already been released, Lenovo has spent its time wisely to produce a better-cooled, more versatile offering.

When we talked to the man leading the presentation, Joey Bell, he explained why he was so confident. Due to the extra space for cooling Lenovo has allowed, he said there's minimal throttling, so he was yet to find a game that didn't run smoothly on his prototype. And this was a prototype running on the AMD Ryzen Z1 processor rather than the Z1 Extreme, on sale for $699.

That model includes 512GB of storage (there is also a 1TB version), with all versions shipping with a vivid 8.8in OLED screen. It's bright, peaking at 500cd/m2, and covers 97 percent of the DCI-P3 gamut, according to Lenovo. You can choose between 800p and 1600p modes, with refresh rates up to 144Hz.

As the Legion Go runs Windows 11, there's even the prospect of using it as a mini PC. Lenovo has built a trackpad into the right controller—when detached you can pop it into a magnetic holder, and it turns into a mouse. There's even a kickstand, so you don't need to find a way to prop up the screen.

into a 3D 2K display. It's truly remarkable in use, and the only software it needs is Lenovo's own 3D Explorer to view the models.

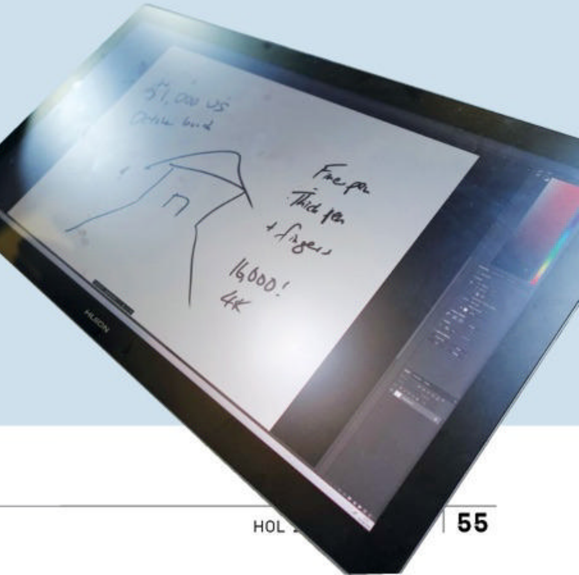
It's also a top-quality panel, calibrated to the Adobe RGB and DCI-P3 color spaces. We look forward to testing it next year.

HUION KAMVAS PRO 19

Our eye was caught by this 19in graphics tablet sitting on the Huion stand. While Huion was a new name to us, you can buy its tablets in the UK via its website at store.huion.com.

The Kamvas Pro 19 is its latest launch, and aside from its sheer size it has 16,000 levels of pressure sensitivity and a 4K resolution on its side. You can use it flat or in an easel-like position via an integrated kickstand. And it works with either a pen or fingers.

While our editor's artistic prowess has never been a strength (that's his "drawing" of a house to the right), we can reveal that it's easy to use and responds to the lightest touch. It will be available this year for $1,000.



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WINDOWS 11 23H2 UNCOVERED

Take a deep dive into the latest iteration of Windows 11 with your tour guide, *Nick Peers*

IT'S THAT TIME OF YEAR again when Microsoft rolls out a major update to Windows. Despite claiming it was moving away from such huge announcements, Windows 11 23H2 (also dubbed 'Moments 4') contains a surprising number of new features, as well as welcome tweaks to existing ones.

By now, you may be aware of some of them, as features have been rolling out quietly since September. But with the flick of the switch at the end of October, all users should now be able to access the vast bulk of what Windows 11 version 23H2 has to offer.

You'll have seen the headline splashes, but what do these new features actually do, and what smaller—but no less important—updates may have escaped your attention? In this feature, we'll give you a grounding in what to look out for. Crucially, we'll also show you where to find the features in question, and even reveal how to disable some of the more intrusive features, should they not meet your tastes (never mind needs).

From AI-powered personal assistants to passkeys, there's something new for everyone in the new version of Windows 11. Join us on our next tour, starting... now.

THE FIRST THING to do is verify you have the full 23H2 update in place. Don't be fooled by the presence of some or all of the new features—for example, the Copilot preview started rolling out back in September, while some of the new System elements, such as the redesigned Home page, may have been in place on your machine since October.

The definitive answer can be found by navigating to Settings > System, scrolling down to the About section, and making a note of the version and OS build. If the version is still 22H2, then navigate to Windows Update, where you should hopefully find 'Windows 11, version 23H2' waiting to download. If it isn't, and the 'Get the latest updates as soon as they're available' switch is flicked to the off position, you need to flick it on, then check for new updates, at which point it should appear.

Given that many of the new features promised in the Moment 4 update may already be in place, don't be surprised if the actual update to 23H2 is a quick one—see the box below for an explanation on how Microsoft deploys major updates. Once you've been upgraded, it's time to discover those new features.

EMPLOY A COPILOT

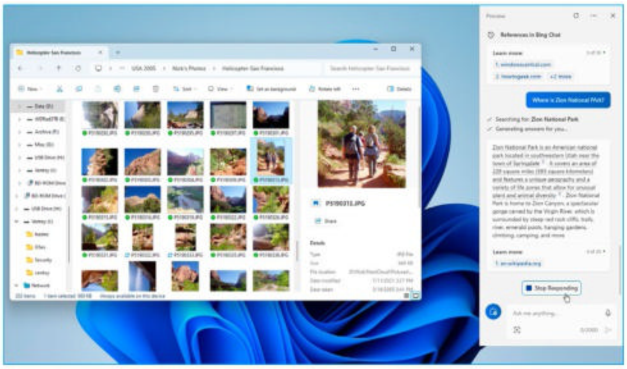
Unsurprisingly, given the rise of ChatGPT and similar 'AI'-powered personal assistants, Microsoft has tied in its Bing Chat tool into Windows 11 with the release of Copilot, which places itself next to the Search button or box. Note the 'pre' label on the icon—a reminder that it's still in the early stages of development.

To Microsoft's credit, Copilot isn't a simple baked-in frontend to Bing Chat and nothing more. It's engineered to sit at the heart of your Windows installation, aimed at helping you quickly get the answers you need, not just to questions you'd normally search the internet for, but Windows too. You're able to use it to quickly get into any part of your system, and you can instruct it to perform those tasks for you instead of being directed to the relevant spot.

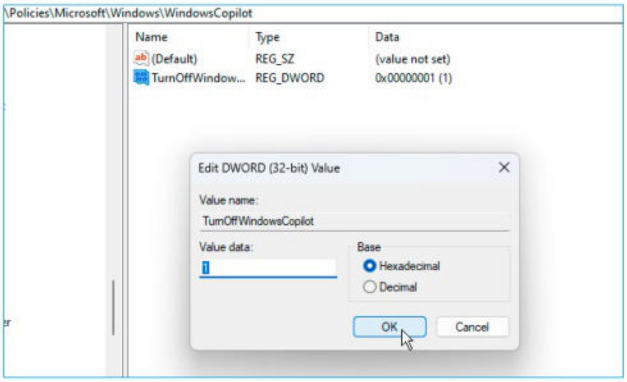
Let's take it for a test run. Click the Copilot icon in the taskbar or use its new keyboard shortcut (Win + C), and Copilot will slide a vertical panel in from the right of the screen, shuffling up the rest of the desktop to make room for it. You can set a choice of conversation style to fit your mood and needs. Three basic options exist: Creative, Balanced (the default, naturally), and Precise.

Beneath this are some examples of what it can do—clicking any of these will send a question to Copilot, from which it will either produce an answer or ask you to confirm an action, such as starting a focus session (Windows' equivalent of do not disturb) of 30 minutes, or snapping your windows into place. After performing the action, the chatbot explains what it's done and provides some suggested follow-up questions that you can click, such as 'How do I snap a window to the left or right?'

Although the response is a little slow, it's a good way to navigate the more obscure parts of Windows—you can carry on with the conversation by manually typing new questions or commands (such as 'Open Settings for me please'), or click the New topic button to the left of the input box to return back to the home page.



Copilot could become your best friend.



\Policies\Microsoft\Windows\WindowsCopilot

Name	Type	Data
(Default)	REG_SZ	(value not set)
TurnOffWindow...	REG_DWORD	0x00000001 (1)

Edit DWORD (32-bit) Value

Value name: TurnOffWindowsCopilot

Value data: 1

Base: ● Hexadecimal ○ Decimal

Completely disable Copilot with the Registry's help.

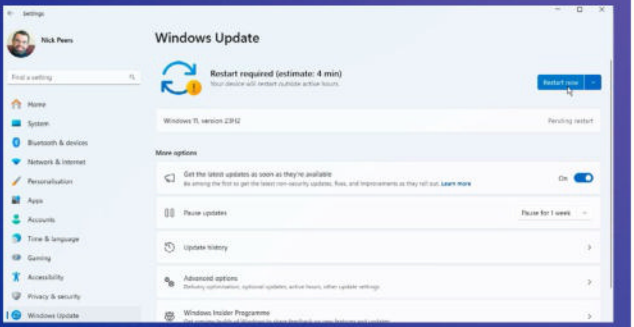
HOW MOMENTS WORK

Gone are the days when a major Windows feature update rolled out in a single package, often gigabytes in size. Since the release of Windows 11 version 22H2, Microsoft has switched to a new means of rolling out updates, one that staggers new features and results in major update files being placed on your PC in advance of the "big date".

In the case of 23H2, most of the files making up the update were on your system before the official update began rolling out in November. They were downloaded as part of a monthly security update, and some of the features were enabled prior to the official announcement—two were Copilot and the redesigned Settings home page.

Other features were kept deactivated until the official 23H2 update rolled out. You may have noticed that this was a small update that downloaded and installed quickly—on rebooting, it threw a metaphorical switch to activate most (if not all) Windows 11 version 23H2's features.

The latest major update's story doesn't end here, though several features may have been held back even after the official switch to 23H2, and will roll out gradually, so if you're unable to find a specific feature mentioned in our roundup, don't fret: it may be blocked by an incompatibility or issue that will see the feature pop up in due course.



Windows Update

Restart required (estimate: 4 min)

Windows 11, version 23H2 — Pending restart

More options

Get the latest updates as soon as they're available — On

Pause updates — Pause for 1 week

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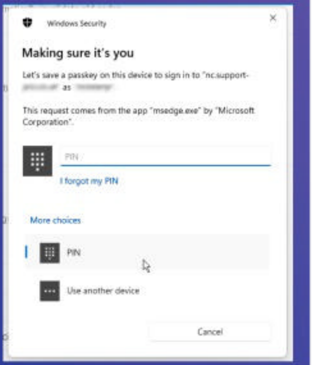
PASSKEY SUPPORT

Passkeys are a new buzzword in security circles, and have been designed to solve the problem of people relying on a short, easily guessable password to protect all their online accounts. Passkeys replace user-generated passwords with a pair of asymmetric cryptographic keys that are harder for hackers to circumvent. The public key remains on the website you log on to, while the private key is generated by your chosen provider and kept on your device, as well as in your secure online password vault.

You'll find an increasing number of password managers are now rolling out support for passkeys—Bitwarden announced its implementation in early November 2023, for example, and now Windows 11 itself has jumped on the bandwagon with the 23H3 release.

If you go to any app or website in Edge or Google Chrome that offers passkeys as an option when signing up or supports creating passkeys within existing accounts, you'll be able to generate one based on the Windows Hello credentials you use to log into Windows itself, whether that's your fingerprint, face, or user-generated PIN. Once done, you can review (and delete) any newly created passkeys by opening Settings and navigating to 'Accounts > Passkey settings'.

If you prefer to generate passkeys using your password manager, first verify its browser extension supports the feature, then simply use that when prompted to generate a passkey. The private key will be stored securely in your password vault instead of being placed in your Microsoft Account.

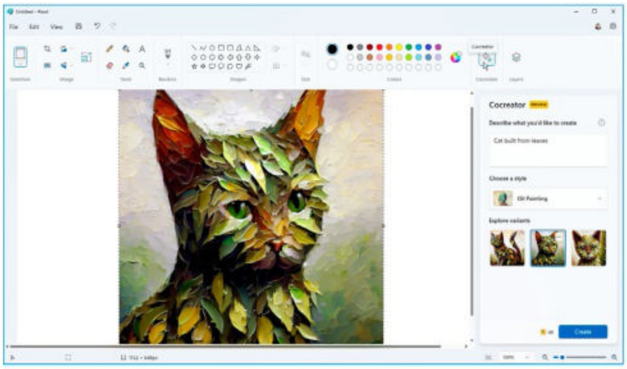


Windows Security

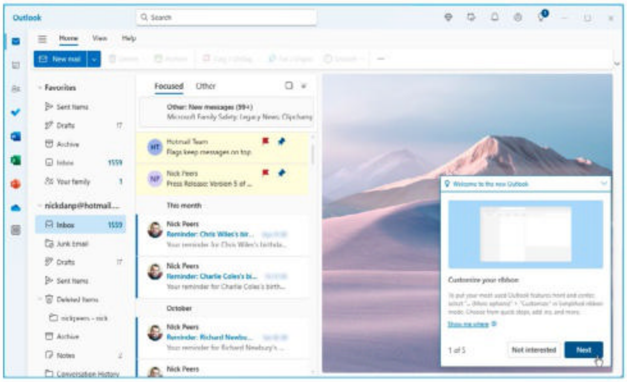
Making sure it's you

Let's save a passkey on this device to sign in to "nc.support-[redacted] as [redacted]

This request comes from the app "msedge.exe" by "Microsoft Corporation".



Paint can now create AI-powered images on demand.



Outlook becomes the default Windows mail tool.

You'll see a mic icon that allows you to interact with Copilot using speech (part of a wider accessibility drive in Windows 11 23H2), and questions can be up to 2,000 characters long. Looking beyond your PC, Copilot brings the power of Bing Chat to your desktop, with all the caveats of AI-powered chatbots: question marks over privacy, accuracy of the results (although Bing Chat will at least provide links to its sources), and so on. If you'd rather not use Copilot, you can disable it by hiding the Taskbar icon via Settings > Personalization > Taskbar and disabling the keyboard shortcut via Settings > Accessibility > Keyboard.

If you want to go further and switch it off completely, then Windows 11 Pro users can do so via Group Policy Editor: press Win + R, type gpedit.msc, and hit Enter. Expand 'Administrative Templates > Windows Components > Windows Copilot' under User Configuration, and then simply double-click 'Turn off Windows Copilot' and select Enabled, before clicking Apply, followed by OK.

Windows 11 Home users will need to navigate to the following Registry key: HKEY_CURRENT_USER\Software\Policies\Microsoft\Windows\WindowsCopilot (if there's no WindowsCopilot key, right-click the Windows key and choose 'New > Key' to create it. Once in place, select WindowsCopilot, then choose Edit > New > Dword (32-bit) Value. Rename the value TurnOffWindowsCopilot, then double-click it and change its value to 1. Restart Windows Explorer from Task Manager to finish.

MORE AI FEATURES

Copilot isn't the only Windows feature to benefit from AI enhancements—several built-in Windows tools have been given access to AI-powered features too. Remember when Paint was just a simplistic editing tool? No more—the app now gains a Cocreator button that when pressed unlocks a tool that allows you to simply define the image you'd like to create, choose a style, and then pick your choice from a selection of variants. The feature is credit-based—each new image costs you a credit, and you start with 50. Paint also gains support for layers, offers an automatic one-click background removal tool, and finally unveils a dark theme along with improved incremental zoom control.

A similar co-creation tool can be found in Microsoft Clipchamp, aimed at helping you create your own movies around answering a few questions, which lead it to offering up recommended scenes, edits, and a narrative. Elsewhere, the Snipping tool now allows you to record sound alongside video, while two new text actions (extraction and redaction) have also been added.

Photos also gains new features, from background blur and slideshow support to enhanced search tools that are even more effective with photos stored on OneDrive, while Notepad now automatically saves whatever text is in the editor when it's closed, giving you the option of restoring it the next time you open it.

Speaking of apps, wave goodbye to the separate Mail and Calendar apps; in their place, Microsoft has now unveiled a free version of its Outlook tool, which combines both.

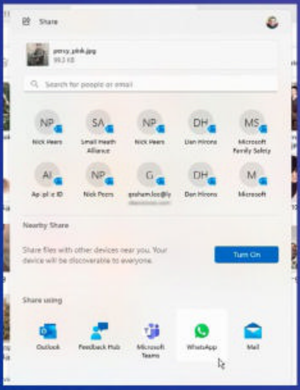
FILE EXPLORER UPDATES

It's often overlooked, but File Explorer remains a crucial part of your everyday experience in Windows, and Microsoft continues to evolve new and 'improved' features. One visible example can be found by pressing Alt + Shift + P to reveal a new details pane. Not only does this provide more details about the selected file, including a thumbnail (if supported), it also provides a shortcut to the file's properties dialog, as well as a Share button for sharing the file via email, connected app, or to nearby Windows devices.

Elsewhere, OneDrive continues to be tied more firmly into the OS. File Explorer's redesigned Address Bar now displays a 'Syncing' status when browsing OneDrive folders that are transferring files to or from the cloud. Click the OneDrive icon in the Address Bar, and a box provides a summary of your storage usage, plus shortcuts to the OneDrive settings panel and your online account portal.

File Explorer's tabs function also gets improved—the ability to click and drag individual tabs away from the main window to create a separate window. You can also reverse the procedure by dragging a tab in one window on to the tab bar of another to join them again.

All welcome tweaks, but sadly it's not all good news, though—you can no longer drag files on to the Address Bar to easily transfer them out of the current folder to somewhere further up the folder hierarchy.



Share files with other devices near you. Your device will be discoverable to everyone.

REVAMPED BACKUP TOOL

Another splashy new feature in the 23H2 update—also rolling out to Windows 10 machines—is the long-awaited replacement for Windows' old Backup tool. 'Windows Back up' is accessed directly from the Start menu (make sure you type 'back up' and not 'backup', otherwise you'll struggle to locate it). Once launched, you'll see options to include folders, apps, various Windows settings, and credentials (Wi-Fi networks and saved passwords), most of which are already pre-selected.

Sadly, it's not a particularly serious tool. One major issue is that the tool backs up everything it covers to the cloud—apps, various settings, and credentials don't take up much space, but folders require you to utilize your OneDrive storage, which needs to be up and running. If you're syncing those folders elsewhere—say, Nextcloud—then don't bother launching OneDrive as a failsafe, as the tool will refuse to back them up separately anyway.

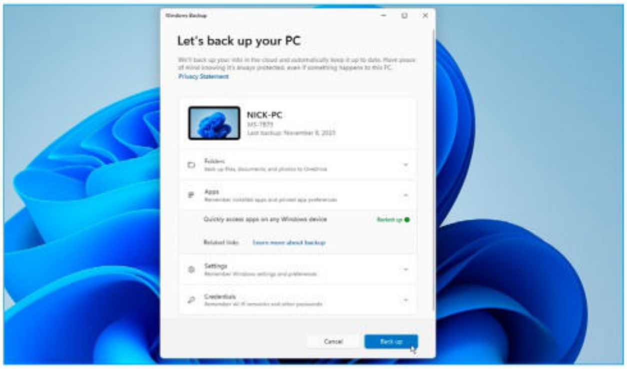
Check your backups' status via 'Settings > Accounts > Windows back up'. You can't restore anything directly from the tool itself; either restore individual folders and files using OneDrive's own tools, or wait until you're transferring to a new PC or reinstalling Windows from scratch, when the option to restore everything will be presented during the post-install setup process.

For those still using other Windows back-up tools like System Restore or File History, they continue to work, even with this new underwhelming interloper in town—at least for now.

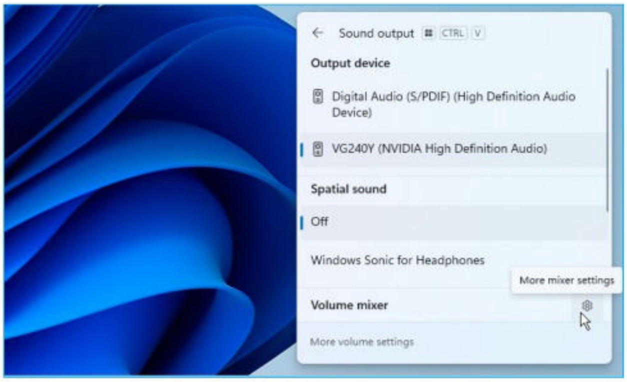
DESKTOP UPGRADES

Windows 11 23H2 features a smattering of new and improved features across the desktop, Start menu, and taskbar. If we start with the Start menu, it gains a couple of tweaks to its Recommended section, which are still slowly rolling out, so may not be instantly accessible. The first sees a thumbnail preview pop up when you roll your mouse over an entry in the list, while the second changes the ranking system to consider more than just the file extension and when it was last opened.

The taskbar features two notable improvements. The first allows you to force a "never combine" mode, which ensures that you're able to view application windows and labels separately on the taskbar. Enable this via the 'Combine taskbar buttons and hide labels' setting after right-clicking the taskbar and choosing 'Taskbar settings', followed by selecting Taskbar behaviors. You'll also see a new option that allows you to choose different behaviors for taskbars on other displays.



Sadly, Windows 10/11's new Back Up tool isn't great shakes.

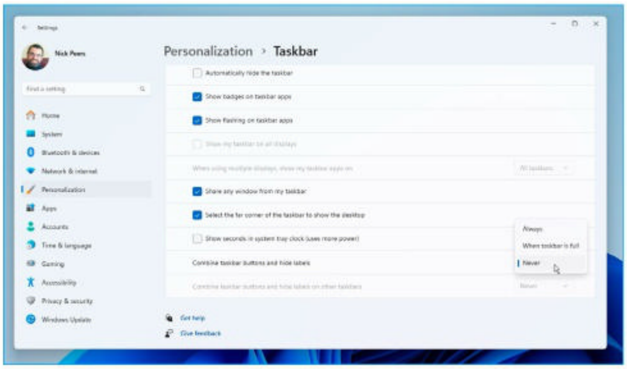


Sound output
Output device
Digital Audio (S/PDIF) (High Definition Audio Device)
VG240Y (NVIDIA High Definition Audio)
Spatial sound
Off
Windows Sonic for Headphones
Volume mixer
More mixer settings
More volume settings

Gain greater control over your sound from the taskbar.

The other improvement requires you to navigate to Settings > System> For developers where you'll see a new 'End Task' toggle, flick this switch to on, and a 'End task' option appears when you right-click an open app's icon in the taskbar. This isn't recommended for day-to-day use, but is handy for forcing non-responding apps to close without having to open Task Manager.

Moving on to the system tray, you can now wield more control over your audio devices in Quick Settings thanks to a more powerful volume mixer. Access it via a button next to the existing volume slider or by pressing Ctrl + Win + V. You can switch output device and configure spatial sound from here, plus gain direct



Personalization > Taskbar

☐ Automatically hide the taskbar

☑ Show badges on taskbar apps

☑ Show flashing on taskbar apps

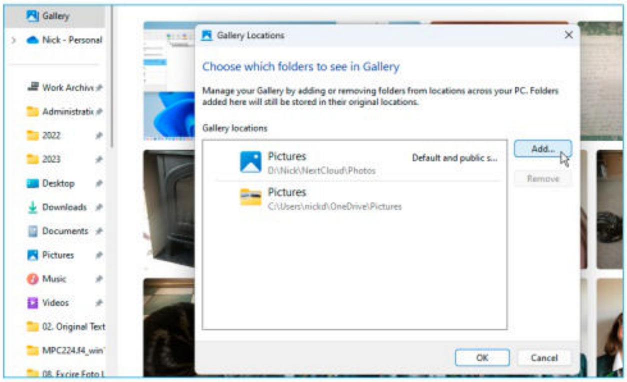
☑ Share any window from my taskbar

☑ Select the far corner of the taskbar to show the desktop

☐ Show seconds in system tray clock (uses more power)

Combine taskbar buttons and hide labels: Never

Force the taskbar to never combine buttons or hide labels.



Gallery Locations

Choose which folders to see in Gallery

Manage your Gallery by adding or removing folders from locations across your PC. Folders added here will still be stored in their original locations.

Gallery locations

Pictures — D:\Nick\NextCloud\Photos — Default and public s...

Pictures — C:\Users\nickd\OneDrive\Pictures

Recreate the Photos gallery view directly in File Explorer.

access to the volume mixer in Settings, where you'll find another new feature: the ability to set different volumes for different apps.

Elsewhere, network problems become easier to diagnose in this update thanks to the added 'Diagnose network problems' option that appears when you right-click the network icon.

If you have no need of the date or time prompt in the system tray, you can now hide it via a newly added option under 'Settings > Time & language > Date & time', accessible when you right-click the date and choose 'Adjust date and time'.

Finally, the number of notifications are no longer displayed in the system tray; in their place is a single bell icon that fills with a solid color whenever unread notifications are detected.

A NEW GALLERY

The update adds several new features and improvements to File Explorer. You can get a summary in the box opposite, but one stands out. Microsoft has rolled out a new Gallery view, located under the Home shortcut in File Explorer's Navigation pane.

The Gallery is designed to make your photos more visible in File Explorer. It apes the All Photos view in the built-in Photos app, and will display the most recently added photos at the top. When we tested the feature, it appeared to freeze, but leave it to its own devices and the view will appear, complete with timeline.

Click the Collection dropdown menu to see which folders are currently included in the selection (your own Pictures folder is the obvious default)—click 'Manage collection' to quickly add new folders and remove existing ones if you wish. Gallery also allows you to select specific subfolders of folders already added—doing so provides you with the option of filtering the view accordingly.

The Gallery also appears as an option from the file picker dialog, so when looking to edit a photo or insert it into a document, you can use the Gallery as a shortcut.

SETTINGS DASHBOARD

If you spend a lot of time combing through Settings to reach frequently used sections, you'll greatly appreciate its major new addition: a new home tab that resembles a dashboard. This places key tools—personalizing Windows, viewing OneDrive usage, and managing Bluetooth devices—front and center, along with shortcuts to your three most frequently visited settings pages.

If you have any RGB peripherals such as mice, keyboards, and monitors, navigate to Personalization > Dynamic Lighting, where you'll find a new section dedicated to letting you control their features without having to install third-party software. It's also the place to apply effects consistently across supported devices.

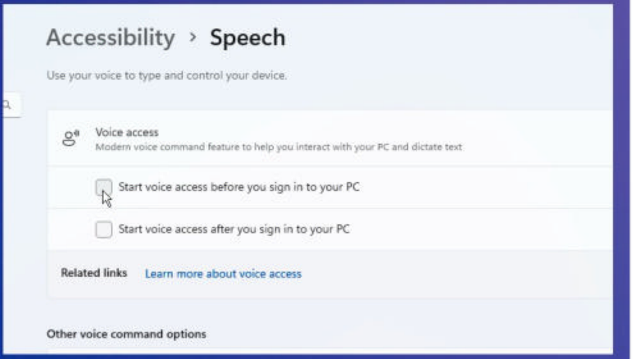
The volume of new and improved features (along with a few disappointing regressions) makes Windows 11 23H2 a largely compelling update—any features you don't like can be ignored or switched off. If you can't find a switch, email us at doctor@maximumpc.com, and we'll see if we can dig it out for you! ⏻

DON'T BLINK...

The new update isn't just about splashy headline features; you'll find lots of little improvements of the 'blink and you'll miss them' variety. Let's start with expanded support for compressed formats. It's been over 20 years since Windows first built in direct support for opening, editing, and creating zip files, and now 11 formats have been added, including .7z, .rar, and various iterations of .tar files.

The desktop, taskbar, and system tray are littered with minor tweaks too—if you make use of Windows Task View to run multiple desktops, a label appears identifying each desktop as you cycle between them using the Win + Ctrl + arrow keys.

Laptop users with supported sensors can configure their laptop to act more proactively to reduce energy consumption and boost security. Visit Settings > Power & battery, and look for a Presence Sensing entry—if it's there, you'll be able to enable features like Adaptive Dimming, which senses when you're not focused on the screen, and dims your display accordingly. In a similar vein, Wake On Approach and Lock on Leave ensure that your laptop is safe when left unattended, but ready to serve when you return.



Accessibility > Speech

Use your voice to type and control your device.

Voice access

Modern voice command feature to help you interact with your PC and dictate text

☐ Start voice access before you sign in to your PC

☐ Start voice access after you sign in to your PC

Related links: Learn more about voice access

Other voice command options

For a guide to what's new in Windows 11 23H2, go to https://support.microsoft.com/en-us/help/5031455, where Microsoft has compiled an exhaustive list of new and improved features.

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DISCOVER THE ALTERNATIVE TO APPLE AND WINDOWS

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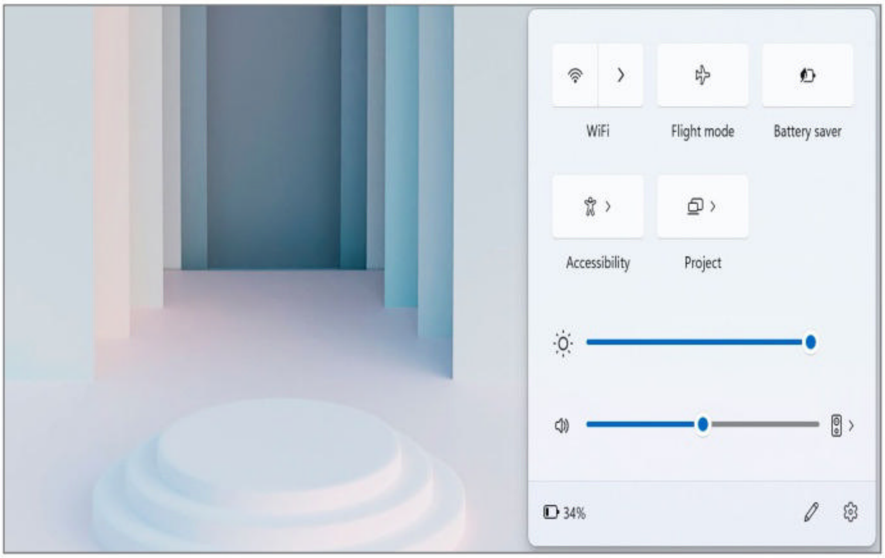
HOW TO

STEP-BY-STEP GUIDES TO IMPROVING YOUR PC

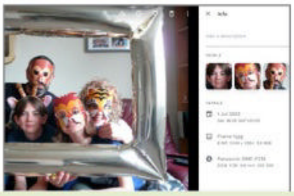
TIP OF THE MONTH



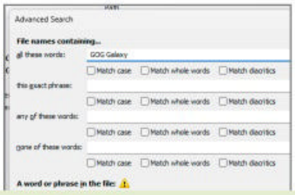
QUICK SETTINGS

To make changes in Win11, there are plenty of tricks we can apply. One is quick settings, which can be found in the bottom right-hand side of your taskbar or by pressing the Windows key + A. You'll find Wi-Fi, Bluetooth, brightness, and other quick access settings here. To customize, hit the pencil icon next to the settings, and add your most-used tools.

MAKE – USE – CREATE



64
Self-host your photos and videos with Immich



68
Find anything on your computer with Everything

70
Beat OneDrive's new photo storage limitations

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SAM LEWIS
STAFF WRITER

NVIDIA WOW FACTOR!

After prolonged access to Nvidia's latest AI tech, DLSS 3.5, it was inevitable that I'd fall into a trance of gaming paradise. For me, it's lived up to its high expectations, and makes the argument to pick up a compatible budget-end 40 series GPU even more compelling. Using an Intel Core i5-13600K paired with said RTX 4060 from Zotac, this is a budget to mid-range machine that can produce a high-end gaming experience thanks to DLSS 3.5. Raytracing is even more stunning than before, and with the introduction of ray reconstruction, you can amp things up using a more powerful RTX 40 series card like a 4080/90.

I got to try this with *Cyberpunk 2077.* I was due to use the *Phantom Liberty* expansion pack, but decided to start the game from scratch and complete it before doing so.It was great to experience the game from the start again by taking full advantage of DLSS 3.5. The performance and visuals were stunning, greatly adding to the immersion. On QHD resolution and high settings with DLSS activated, I achieved around 120-150 fps, which was great for my 120Hz monitor. If you want to get the most bang for your buck, an RTX 4060 is a great route to take. Just make sure your favorite games support DLSS 3.5, okay?

↘ submit your How To project idea to: editor@maximumpc.com

Self-host your photos & videos with Immich

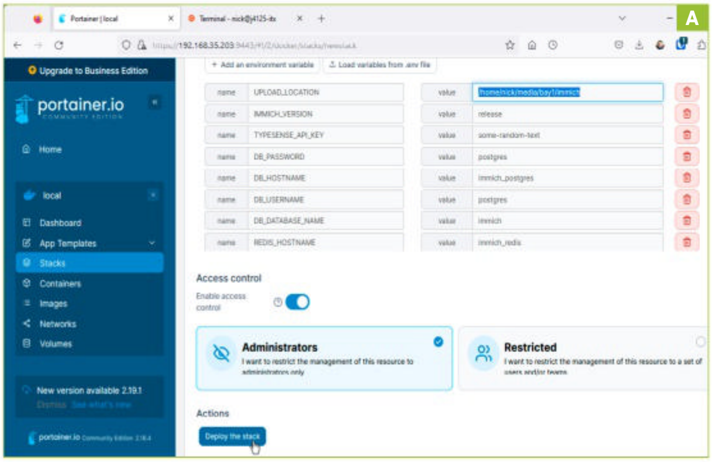
YOU'LL NEED THIS

FREE AND OPEN SOURCE IMMICH SERVER SOFTWARE AND MOBILE APPS (https://immich.app). The server software requires a PC running Docker with Docker Compose or Portainer also installed.

FED UP WITH HAVING TO BUY a monthly subscription to keep your photos and videos backed up online? If you're willing to use your own backup server—whether your own PC or the NAS build we featured back in September 2022—then you can back up your entire family and friends' photos and videos for free. Immich is a fresh, open-source server that's rapidly developing to rival the likes of Google Photos and Apple iCloud.

First, Immich supports video, motion photos, and panoramas. You can upload from your computer (and thereby your digital camera) as well as your mobile devices, and it'll recognize existing metadata like date and time information, as well as GPS coordinates to provide you with myriad different ways to view your photos. Immich even sports built-in facial detection technology that automatically links photos to the people in them.

In this tutorial, we'll show you how to get Immich up and running, your photos uploaded, and take you on an extensive tour of its features. We'll even show you how to use free software on your PC to add missing tags and ensure that your media is seen in its best light. **–NICK PEERS**


A
Portainer | local
Terminal - nick@j4125-itx
https://192.168.35.203:9443/#!/2/docker/stacks/newstack
Upgrade to Business Edition
portainer.io
COMMUNITY EDITION
Home
local
Dashboard
App Templates
Stacks
Containers
Images
Networks
Volumes
New version available 2.19.1
portainer.io Community Edition 2.18.4
+ Add an environment variable
Load variables from .env file
Access control
Enable access control
Administrators
I want to restrict the management of this resource to administrators only
Restricted
I want to restrict the management of this resource to a set of users and/or teams
Actions
Deploy the stack

name	value
UPLOAD_LOCATION	/home/nick/media/bay1/immich
IMMICH_VERSION	release
TYPESENSE_API_KEY	some-random-text
DB_PASSWORD	postgres
DB_HOSTNAME	immich_postgres
DB_USERNAME	postgres
DB_DATABASE_NAME	immich
REDIS_HOSTNAME	immich_redis

1 INSTALL IMMICH

Immich is distributed as a series of interconnected docker containers, which can be installed in several different ways. If you're using the command line, then the instructions for the Docker Compose option (https://immich.app/docs/install/docker-compose) are the logical ones to follow; if you set up the Portainer web-based frontend following our instructions in the October 2022 issue, go to https://immich.app/docs/install/portainer to find out how to install it using Portainer's stacks feature, as shown in [**Image A**].

» In either case, the key environment variable you need to supply is UPLOAD_LOCATION, which is the folder where all your media will be stored when uploaded to your server. That's all you need to worry about if you're keeping your Immich server restricted to your local network only—if you'd like to be able to upload photos and videos while on the road with your phone or tablet then check out the box for additional setup instructions.

» After you execute the Docker Compose file or launch the stack in Portainer, it's best to sit back and be patient—it can take up to 10 minutes for Immich to create and set up the eight containers it relies on. Once the containers are all up and running, open your web browser and navigate to http://192.168.x.y:2283 (where 192.168.x.y is your server's IP address) to get started.

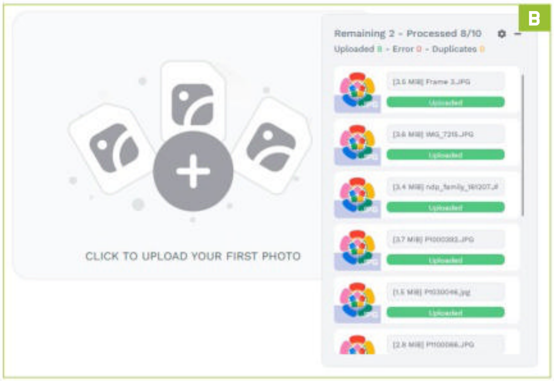
2 YOUR FIRST UPLOAD

Click 'Getting Started' to set up the master Admin account. You'll need to supply your email address, a password, and your first and last name. Click 'Sign Up', and you'll be prompted to log in with your newly created credentials and taken to the main Immich web interface.

» This is simple to navigate—the annotation provides a quick refresher going forward—but your first task will be to click the invitation to upload your first photo from your computer. Click this, and the usual file picker appears. You can upload a single photo or select multiple photos from a single folder—click Open, and you'll see a file upload progress pop-up appear on-screen, as shown in [**Image B**].

» When the file has been uploaded, press F5 to refresh the page, and your uploaded photos should appear on-screen. You'll see that they're filed according to their date—this is determined either by information stored as metadata in the file itself, or failing that, by the file's own creation date. The vertical timeline on the right is used to quickly skip back and forth through your photos. Use the Upload button at the top of the web interface to upload more photos from your PC if required.

» Click a photo to open it full screen. You'll see a series of controls across the top—a magnify button shows the image at its original size (or you can use your mouse


B
CLICK TO UPLOAD YOUR FIRST PHOTO
Remaining 2 - Processed 8/10
Uploaded 8 - Error 0 - Duplicates 0
[3.5 MiB] Frame 3.JPG
Uploaded
[3.6 MiB] IMG_7215.JPG
Uploaded
[3.4 MiB] ndp_family_161207.jl
Uploaded
[3.7 MiB] P1000392.JPG
Uploaded
[1.5 MiB] P1030046.jpg
Uploaded
[2.8 MiB] P1100066.JPG

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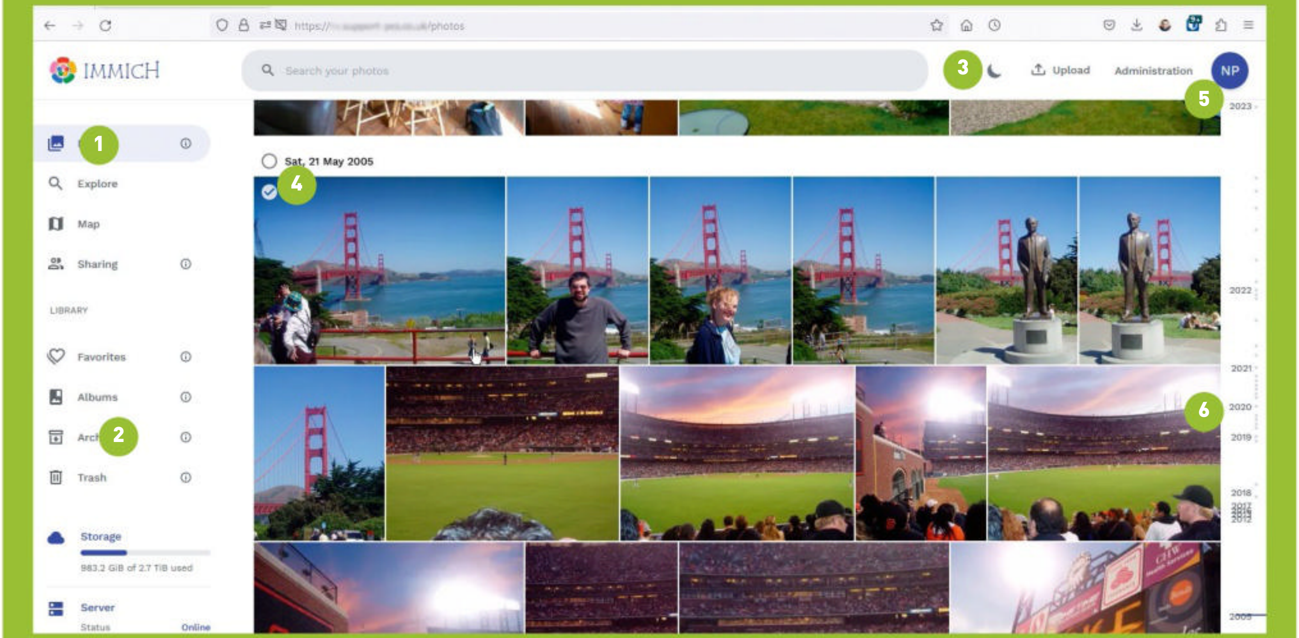
TAKE THE IMMICH TOUR



1. BROWSE COLLECTION Immich offers four ways to browse your collection—the default Photos view arranges your photos by date, with the most recent at the top.

2. ARCHIVE ITEMS Individual photos can be removed from the main view by being archived (click the ellipsis button and choose Archive after selecting them). Click here to view them.

3. SWITCH THEME At present, Immich supports two themes: light and dark—click this button to switch between them. Further customization (via Administration > Settings > Theme Settings) requires knowledge of CSS.

4. SELECT ITEMS QUICKLY Roll your mouse over a photo and check the box to select that photo, or check the box next to a day to select all photos on that date. Use the options that appear at the top of the screen to edit or organize the selection.

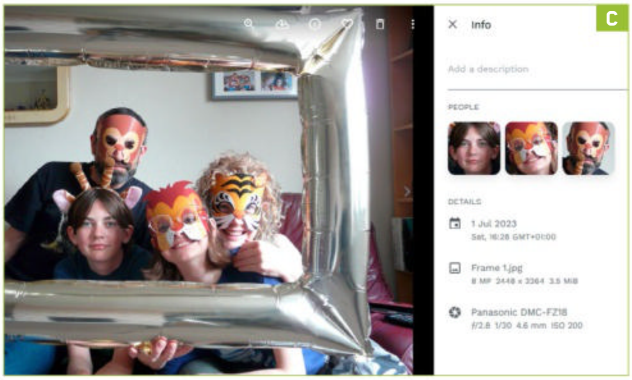
5. ACCESS USER PROFILE Click your user initials to reveal an Account Settings button, allowing you to access user-specific settings, such as being able to view (and revoke) logged in devices.

6. TIMELINE When in Photos view, use the vertical timeline to jump to a specific year's photos instead of furiously scrolling with the mouse wheel.

scroll wheel to zoom in and out), while next to it is a download button, followed by an information button (more on that shortly).

» Next to this is a button for 'favoriting' the image, which basically adds it to the Favorites library. There's also a trash button—one click, and the photo is moved to the trash, from where it will be deleted in 30 days unless you navigate to Library > Trash to restore or permanently delete it ahead of time.

» The final button reveals a pop-up menu, which has a host of options that are largely self-explanatory.



Add a description

1 Jul 2023
Sat, 16:28 GMT+01:00

Frame 1.jpg
8 MP 2448 x 3264 3.5 MiB

Panasonic DMC-FZ18
f/2.8 1/30 4.6 mm ISO 200

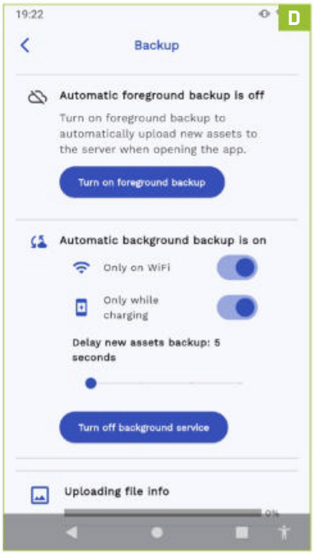
3 VIEW FILE METADATA

Returning to the 'i' button, clicking this reveals your photo's Info pane, which basically includes the metadata embedded in the file, as well as space to add a description to the photo. The metadata that's included depends on what's recorded: at the very least, you should hope to see a date and time stamp, plus technical details about the photo (size, resolution, and file size). If you took the photo with a digital camera or phone, you should also see technical details recorded by your device—for example, your camera may display ISO and f-stop settings among other information.

» If you've uploaded a photo that contains GPS data pointing to where it was taken, you'll also see the location on a small map.

» Regardless of the photo's source, Immich will also attempt to detect faces in the photo, as shown in [Image C]. Click a face, and you'll discover that Immich has been beavering away in the background applying facial recognition to all your photos and attempting to group photos of the same person together. Click 'Add a name' at the top, and enter their name.

» Don't be surprised if a person's photos are split across two or more individual entries (for example,



D

19:22

Backup

Automatic foreground backup is off

Turn on foreground backup to automatically upload new assets to the server when opening the app.

Automatic background backup is on

Only on WiFi ●

Only while charging ●

Delay new assets backup: 5 seconds

Uploading file info

0%

photos from different life stages). When you start typing their name for the new entry, the original entry should pop up beneath it—click this to merge the two.

» You'll also see a vertical ellipsis button in the top right, where you'll find more options—changing the 'featured' face, adding a date of birth, and hiding a face—for privacy reasons or to exclude unknown faces or passersby in photos, for example.

4 LINK MOBILE DEVICES

Before exploring Immich further, it's time to tie in your phones and tablets. You'll find free apps for Android, iOS, and F-Droid in their respective stores—once installed, launch the app, after which you'll be prompted to enter the 'Server Endpoint URL'—if you're connecting locally, this will be http://192.168.x.y:2283/api, but if you're connecting through your reverse proxy, it should point to your domain or subdomain via the https proxy (for example, https://immich.domain.com).

» Next, log in using the username and password you set up in Immich earlier, and you'll be prompted to give Immich permission to access all your photos and videos, which you should do. You'll then find yourself at a screen not too dissimilar to the main Immich web interface, with any previously uploaded photos on view.

» Tap the cloud backup button in the top right-hand corner, where you'll be able to select which albums to back up, then configure automatic foreground and background backing up as shown in [**Image D**], so you don't have to manually keep an eye on Immich while it transfers your media to the server (look for the handy 'Only while charging' option to restrict Immich's background uploads to when your mobile is connected to the mains). Once configured, click 'Start Backup' and watch while Immich begins the process.

» Return to the main web interface and periodically refresh the page—you should start to see your mobile photos appear as they're uploaded, indicating that they're now backed up to your PC or server. You'll need to exercise some patience—it can take weeks, if not months, to back up your entire photo or video library. Periodically return to the Backup page to verify that files are uploading as they should—sometimes it can stall, in which case click Cancel followed by Start Backup to resume the backup process.

5 EXPLORE AND ORGANIZE YOUR COLLECTION

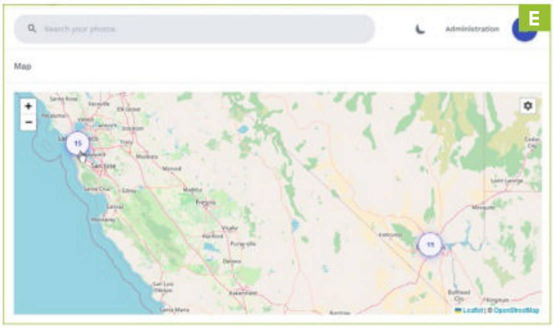
As your collection grows, you'll want to do more than simply view them by date and time. Immich offers four basic views, as summarized on the annotation: Photos is the timeline-based view, while Explore allows you to browse photos by the people in them, by the place (for any geotagged photos), activity (those marked as favorites or recently uploaded) and category, which allows you to filter the view to show only videos, motion photos (short video sequences), and panoramic photos.

» The third view is Maps, which will place all those geotagged photos on a world map—just move around and zoom in and you'll see clusters of photos break off as more localized places appear as shown in [**Image E**] . Click on a number to view all those photos in a slideshow.

» The final view—Sharing—will come into play once you've set up more users and explored how to manage your collection with additional organizational tools.

» The Library section, which is accessible in the mobile app so you can manage your collection on the go, has four options. In addition to Trash, Favorites will list photos you've marked by clicking the heart button when viewing them, while Albums is where you'll have most joy creating custom views. As with photos, you'll see an invitation to create an album—click the button, and you'll be prompted to add a title and (optional) description.

» Beneath this is a 'Select Photos' button—click this to go through all available photos, rolling your mouse over one to reveal a check button to allow you to select



E

ACCESS IMMICH REMOTELY

If you'd like to access Immich while on the road—particularly if you're looking to back up photos and videos while traveling—you'll need to follow similar steps to all the other Docker containers you've configured in a similar manner. First, you'll need a subdomain or dynamic domain pointing towards your home network via its public IP address (https://whatsmyip.com), which may require you to reconfigure a ddclient container or similar tool for ensuring the domain is redirected whenever your public IP address changes.

Second, you'll need to make sure the immich_proxy container is joined to the same bridge network as your reverse proxy—do this in Portainer by browsing to its Details page, then scrolling down to the bottom, selecting the shared bridge network from the dropdown menu and clicking 'Join network' (it should remain connected to the immich_default network).

Finally, configure your reverse proxy. If using Nginx Proxy Manager, add a new proxy host pointing to your chosen domain or subdomain. Leave scheme set to http, set Forward Hostname/IP to immich_proxy and Forward Port to 8080. After setting up your SSL certificate for secure remote access, click OK, and verify the connection works in your web browser by browsing to the selected domain (such as https://immich.domain.com).

© IMMICH

it. You can also upload photos directly from your PC (click 'Select from computer') to the album. Once selected, click Done.

6

ADD NEW USERS

You now have the basics of Immich sorted—take the time to visit the Administration panel, where you can configure Immich's settings, peek behind the scenes via a series of server stats, plus perform any repairs to your database that Immich may suggest going forward.

» This is also the place to come to add additional users to Immich. Doing so allows you to extend your new self-hosted photo storage solution to other friends and family. Fill in the required details—keep the password relatively simple, as your user will need to change it when they first log in. Note that they won't be emailed any information—you'll need to communicate directly with them and step them through the process of logging on to the server through their own web browser or mobile device(s). Once set up, each user can upload files to their own private space—you won't be able to view their photos (and they won't be able to view yours) unless you specifically set up a shared album.

» To do this, select Sharing and click 'Create shared album'. Set it up in the usual fashion, but make a note of the shared button at the top between the 'Add Photos' and 'Delete album' buttons. Clicking this lets you add other users to the album—they'll be able to view and add their own photos to the album. If your Immich server is accessible via the internet, you can also generate a public link to allow others to view the album through their web browser as shown in [**Image F**]. The link can be password-protected, plus you can allow users to download photos and even upload if you'd like them to contribute to the album. The link can also be set to expire after as little as 30 minutes or as long as 30 days.

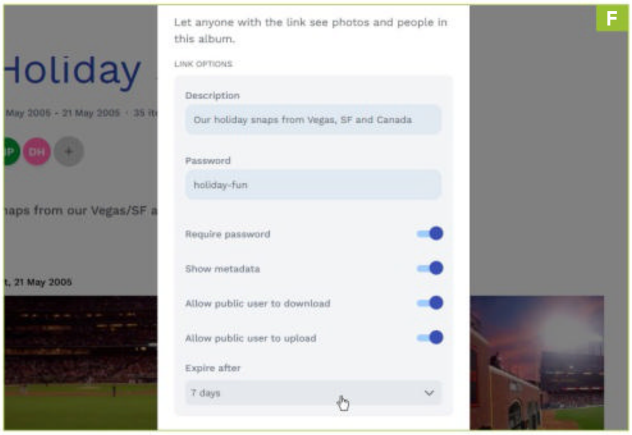
7

EDIT PHOTO METADATA

One thing currently lacking from Immich is the ability to edit your photo metadata from within the app. As a result, you're stuck with the metadata applied to the file when it's uploaded, so you need to edit this manually on your PC.

» The excellent open-source digiKam (www.digikam.org) photo organizer has all the tagging tools you need. After installation, go through the first-run wizard, choosing your 'home' photos folder and remembering to check 'Add information to files' when asked about configuring metadata storage. Once complete, the program will go through all the photos in your default Pictures folder, then offer to download a facial recognition feature, which can be skipped.

» When the main window opens, select 'Settings > Configure digiKam'. Select Metadata in the left-hand pane and check 'Geolocation information (GPS)' to ensure digiKam saves geocoordinates to the files. Once done, click OK, and browse to the folder containing your images. To edit core metadata, select your item(s) and choose 'Item > Edit Item Metadata' to open a new window. Work through the sections on the left (including Date & Time), then click Apply, followed by Close to write any changes to the file. To geotag your photos, check out the box.



Let anyone with the link see photos and people in this album.

LINK OPTIONS

Description: Our holiday snaps from Vegas, SF and Canada

Password: holiday-fun

Require password ●

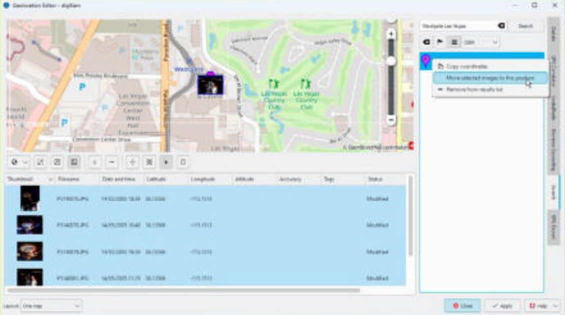
Show metadata ●

Allow public user to download ●

Allow public user to upload ●

Expire after: 7 days

GEOTAG YOUR PHOTOS



To make use of Immich's Maps view, your photos need to have geocoordinates attached to their metadata. If your photos lack this, you can add it using digiKam. Select all the photos needing tags, then choose 'Item > Edit Geolocation' to open a view of the world. You can zoom into the map manually or click Search to find a location. If the location is where the photo was taken, select the photo(s), right-click the search result, and choose 'Move selected images to this position' to apply the geocoordinates as shown in Image G. Click Apply to write the geocodes to the files.

If you need a more precise spot, position the crosshairs where the photo was taken, then right-click and choose 'Copy Coordinates'. Select the relevant photos, right-click and choose 'Paste Coordinates' followed by Apply as before.

When you're done applying coordinates, click Close and then quit digiKam before uploading the photos to Immich—if you're replacing previously uploaded files, Immich will simply upload these alongside the originals, so remove the old files from Immich before you upload new versions.

8

UPDATE IMMICH AUTOMATICALLY

Immich is under rapid development, with major new features being added all the time and new versions rolling out almost weekly. Destroying and recreating the stack each time to keep it up to date is a fiddly process at best—in Portainer, navigate to the Immich stack, then switch to the Editor and scroll down until you find the 'Update the stack' button underneath the list of environment variables. Click this, then flick the 'Re-pull image and redeploy' switch to on, before clicking Update.

» The update process takes at least as long as an initial deployment—once the stack is up and running, there's one more step to perform if you've configured Immich for remote access: click the immich_proxy container, scroll down, and rejoin the shared bridge network that connects it to the reverse proxy.

Find anything with Everything

YOU'LL NEED THIS

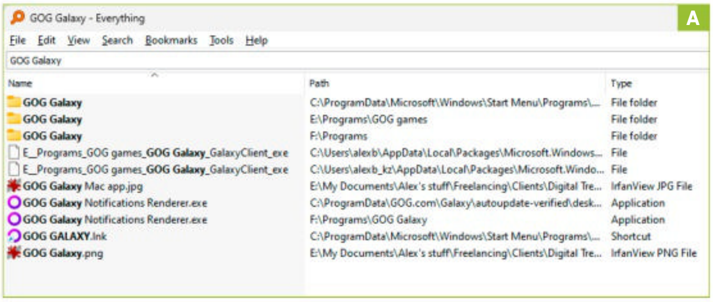
THE EVERYTHING APP
voidtools.com, free

THE LONGER YOU USE YOUR PC, the more it fills up with files and the greater the need to quickly find them. After all, there are few things more frustrating than knowing that you stashed a document somewhere on your computer, but having no idea where it actually is.

You could use the built-in search tool in Windows, but it's hardly the most reliable option. It has a habit of missing boatloads of files, even when you're certain they exist, or are staring right at them. Simply put, Microsoft's search is not dependable enough for everyday use.

What *is* reliable, then? Enter Everything, a fantastic free search tool that leaves no stone unturned in its quest to find your missing docs. Not only is it fast and thorough, it's packed with extras that let you refine your search. It's highly customizable and bursting with ideas to make your searches more accurate. It blows Microsoft's Windows search out of the water.

Our tutorial will show you how to get started with Everything and perform your first searches, as well as how to get to grips with all of its bonus tools and features. Once you're up and running, you'll never look back. **–ALEX BLAKE**



GOG Galaxy - Everything

GOG Galaxy

Name	Path	Type
GOG Galaxy	C:\ProgramData\Microsoft\Windows\Start Menu\Programs\...	File folder
GOG Galaxy	E:\Programs\GOG games	File folder
GOG Galaxy	F:\Programs	File folder
E_Programs_GOG games_**GOG Galaxy**_GalaxyClient_exe	C:\Users\alexb\AppData\Local\Packages\Microsoft.Windows...	File
E_Programs_GOG games_**GOG Galaxy**_GalaxyClient_exe	C:\Users\alexb_kz\AppData\Local\Packages\Microsoft.Windo...	File
GOG Galaxy Mac app.jpg	E:\My Documents\Alex's stuff\Freelancing\Clients\Digital Tre...	IrfanView JPG File
GOG Galaxy Notifications Renderer.exe	C:\ProgramData\GOG.com\Galaxy\autoupdate-verified\desk...	Application
GOG Galaxy Notifications Renderer.exe	F:\Programs\GOG Galaxy	Application
GOG GALAXY.lnk	C:\ProgramData\Microsoft\Windows\Start Menu\Programs\...	Shortcut
GOG Galaxy.png	E:\My Documents\Alex's stuff\Freelancing\Clients\Digital Tre...	IrfanView PNG File

1 DOWNLOAD EVERYTHING

To get started, head to voidtools.com. On the home page you'll see several options for downloading Everything—the standard 64-bit installer should be fine, unless you particularly need the 32-bit, zipped or lite editions. At the time of writing, we used version 1.4.1.1024, but you should just use the latest version available when you go to install it.

2 FIND AND MOVE FILES

When you first open Everything, it will take a moment to build its file list, so give it a minute or two. You'll know it's finished because it'll display a list of files and folders in the app's main window, sorted alphabetically by default.

» Try typing something in the search box at the top of the app. You'll notice that Everything starts narrowing down its results instantly, and every additional letter you type refines the results further. There's no need to press Enter or click a button to bring up your search results, as they populate right away. [**Image A**]

» Once you've got your search results, you can interact with them in much the same way as you would a folder in File Explorer. That means you can right-click a file or folder and get the standard Windows context menu options, or drag it right out of Everything into a File Explorer pane to change its location. Alternatively, click a result in Everything, then click Edit > Copy to Folder or Edit > Move to Folder to shift it somewhere else.

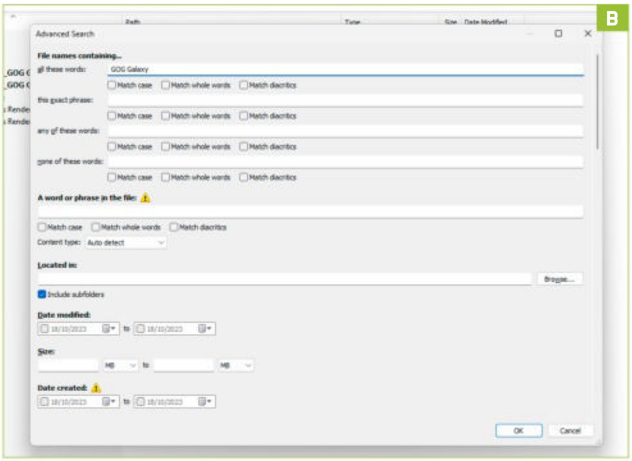
» If you want more control over where a file is copied or moved to, click it, then click Edit > Advanced > Advanced Copy to Folder or Advanced Move to Folder. This presents a few extra options, including changing the format of the file path, matching the case to what you type, and enabling regular expressions (regex).

3 GET GRANULAR

Everything lets you apply filters to your search results to help you find exactly what you're looking for. On a page of results, click Search. At the bottom of the menu you'll see a few options, including Audio, Compressed, Document, and more. By default, Everything is selected, meaning the app will not discriminate by file type or extension. To change that, click one of the options in the menu to filter down by file properties.

» Click Search > Advanced Search [**Image B**]. Here, you'll find a vast array of options that allow you to be much more granular. For instance, you can tell Everything to look for files containing any of the words in your search term, or the exact phrase only. Within these options, you can drill down further by specifying you want the results to match the case you entered and even match any diacritics (such as accents) you have included.

» Aside from file names, you can search for text within a document, locate files stored in certain locations,



all these words: GOG Galaxy

Content type: Auto detect

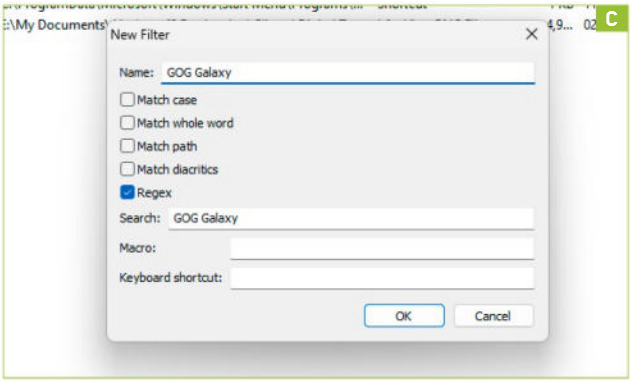
☑ Include subfolders

Date modified: 18/10/2023 to 18/10/2023

Size: MB to MB

Date created: 18/10/2023 to 18/10/2023

©EVERYTHING



New Filter

Name: GOG Galaxy

☐ Match case
☐ Match whole word
☐ Match path
☐ Match diacritics
☑ Regex

Search: GOG Galaxy

Macro:

Keyboard shortcut:

only bring up results created between two specified dates, and much more. Further down the list, you are able to perform more advanced searches, like looking for a list of file names contained in an external text document, or only bringing up results that have a certain number of subfolders. It lets you get incredibly detailed in your hunt.

» With so many options, there's a lot of power to exclude irrelevant results and find what you're after, even among a sea of similarly named results.

4 ADD SOME FILTERS

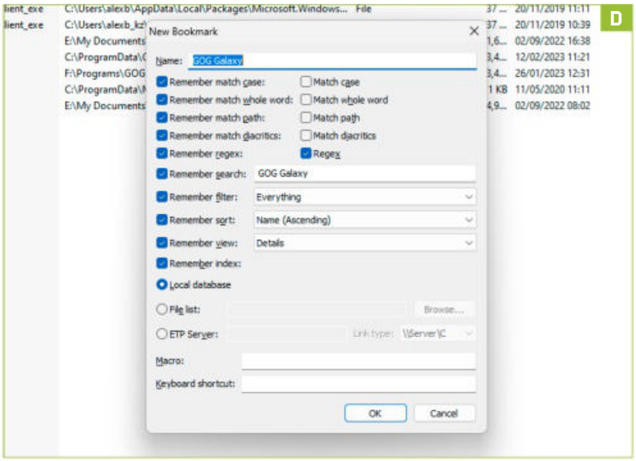
Click Search > Add to Filters. Here, you can create your own filters that can be applied to subsequent searches. At the top of the menu is a box to give your filter a name. Underneath that are checkboxes to tell the app to match certain parameters: text case, whole words, paths, and diacritics. You can enable as many of these as you like [**Image C**].

» There is also a box to enable regular expressions, and a space to enter the exact text that the filter will look for. You can even assign it a macro or keyboard shortcut. When you're done, click OK to save the filter.

» To add or remove filters, click Search > Organize Filters. Here, you can delete, reorder, and edit filters. There are also options for adding, importing, exporting, and resetting them.

5 BOOKMARKS

Sometimes, you'll find yourself applying a dense set of search terms, filters, and sorting options at once. Reapplying all of these can be time-consuming, so instead of adding them all over again every time you load up Everything, you can simply save them as a bookmark. That way, applying them is just a click or two away.



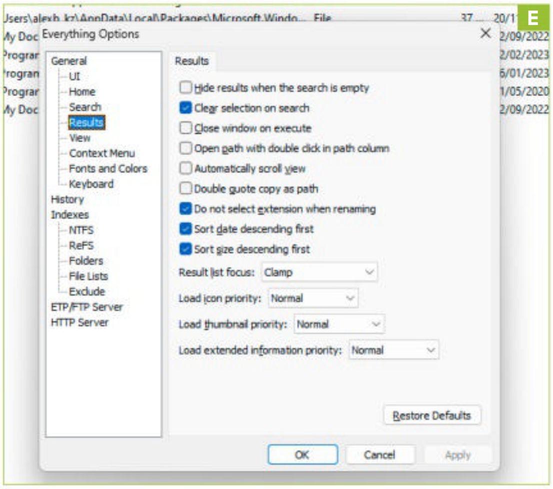
New Bookmark

Name: GOG Galaxy

☑ Remember match case: ☐ Match case
☑ Remember match whole word: ☐ Match whole word
☑ Remember match path: ☐ Match path
☑ Remember match diacritics: ☐ Match diacritics
☑ Remember regex: ☑ Regex
☑ Remember search: GOG Galaxy
☑ Remember filter: Everything
☑ Remember sort: Name (Ascending)
☑ Remember view: Details
☑ Remember index:
● Local database
○ File list:
○ ETP Server: Link type: \\Server\C

Macro:

Keyboard shortcut:



Everything Options

Results

☐ Hide results when the search is empty
☑ Clear selection on search
☐ Close window on execute
☐ Open path with double click in path column
☐ Automatically scroll view
☐ Double quote copy as path
☑ Do not select extension when renaming
☑ Sort date descending first
☑ Sort size descending first

Result list focus: Clamp

Load icon priority: Normal

Load thumbnail priority: Normal

Load extended information priority: Normal

» To do this, add everything to your search parameters that you need to, then click Bookmarks > Add to Bookmarks. You'll see a bunch of choices, some of which will probably look familiar [**Image D**], including options to match various factors. Once you're done, click OK. You can then manage your bookmarks by clicking Bookmarks > Organize Bookmarks.

6 MORE OPTIONS

As you've probably gathered, Everything is extremely customizable, with various ways to improve your search results. You can also adjust how the app works, looks and feels in a broader sense.

» Click Tools > Options, then pick a title in the left-hand sidebar. For example, you can change how the app opens and what it looks like under the UI entry, or tweak how searching works under 'Search item. [**Image E**]

» More advanced options lie further down the sidebar. For instance, you can roll up your sleeves and change how the indexing works, or even configure your own server so that you can use Everything's search from a web browser.

» Another option is to change what your search results look like. You can do this by clicking View in the menu bar, then choosing from four options in the menu. Your choices are extra large thumbnails, large thumbnails, medium thumbnails, or details.

REGULAR EXPRESSIONS (REGEX)

By default, Everything lets you search using plain English, and one of its benefits is its accessibility, despite its power. But if you want a bit more control and flexibility when you search, you can use regular expressions instead. To enable them, simply click Search > Enable Regex.

Regular expressions let you set rules within your search terms. For instance, searching for "Max" would show results with "Max" in the file name, but searching for "^Max" would only bring back results where "Max" lies at the very start of the file name. Everything's developer has a list of the expressions you can use on its website (www.voidtools.com/support/everything/searching/#regex).

Beat OneDrive's photo storage restrictions

YOU'LL NEED THIS

ONEDRIVE ACCOUNT, MEGA.IO ACCOUNT
OneDrive online (free), or a Microsoft 365 subscription (paid). Mega.io account (free)

ONLINE STORAGE PROVIDERS want you to synchronize as much as you can—the more you upload, the more they can charge you for storage. Because you're likely to upload your files and not touch them for years, the charges can roll over month to month, perhaps forever. No wonder they make it so easy to sync automatically.

Take Microsoft's OneDrive. Its software is built into Windows, and OneDrive is the default location for saving Microsoft Office files. The program also lets you sync your Desktop, Documents, and Pictures folders, save photos and videos from other devices, and automatically upload screenshots. This is useful, but syncing a lot of files can push you towards the limits of your account, so you may need to upgrade to a more expensive plan.

But that's not the only way you might use more space than you expect. Microsoft recently told some OneDrive users that from mid-October, adding a photo to an album would mean it counts twice against their allocated storage. This won't be such an issue for Microsoft 365 subscribers, who get 1TB of storage, but it's something to watch out for on the free 5GB tier.

When you add a photo to an album, you don't remove it from its location; you just make it visible within a certain context. Think of an album like a perforated grille, which blocks out all but the images that you've associated with it. Opening an album is like taking a bird's-eye view at your library through that grille, so that only a subset of the pictures remain visible.

It seems unfair, then, that an image in an album should count twice against your storage quota. We explain how to avoid falling foul of OneDrive's storage limits. –**NIK RAWLINSON**

1 ADD YOUR OWN PHOTO TAGS

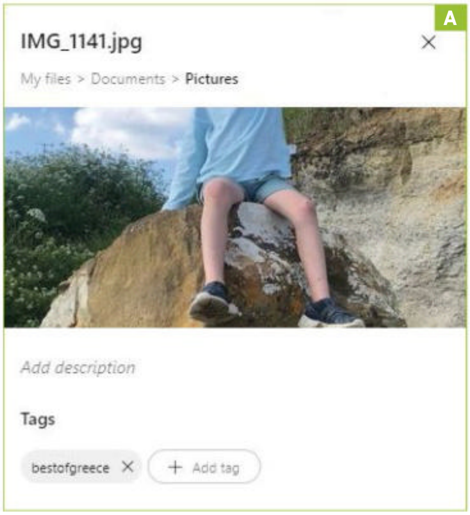
When you upload an image, OneDrive applies tags based on what it thinks it depicts. You can use these to search your library later.

» You can also add tags of your own, and more or less work around Microsoft's double counting. Let's say you've visited Greece every year since 2015. If you took every photo on your smartphone, they will already be tagged with both Greece and the date, plus whatever else OneDrive thinks each image shows.

» If you wanted to create a collection of only your best shots from the last eight years of visits, then rather than creating an album called 'Best of Greece' and having their size counted twice, you could instead add the tag bestofgreece to your favourite shots from each of your visits.

» To do this, log into your account at https://photos.onedrive.com, hover over the photo you want to tag, and click the 'i' that appears in the bottom-right corner. Click '+ Add tag' below the thumbnail in the sidebar this brings up, type your tag then press Enter. It will then appear under the Tags heading [**Image A**].

» Searching 'Greece' shows everything from your trips; '2022' shows photos taken that year (in Greece or elsewhere); and 'bestofgreece' filters everything other than your favorite shots from those trips. OneDrive shouldn't count images twice, as they've never been in an album.



IMG_1141.jpg

Tags

bestofgreece ×

2 MOVE YOUR PHOTOS TO ANOTHER SERVICE

If this doesn't suit you, and you don't want to upgrade to a paid-for OneDrive account, you could transfer to a different online-storage provider. Mega (www.mega.io) is one of the most generous. It gives you 20GB free storage, and is strong on privacy. Your files are encrypted, and only you have the keys to unlock them; not even Mega can see what you're uploading.

» There is a catch: it limits the rate you can download your data at once it's on its servers. We're not sure what the limit is—Mega says it depends on your location and how many people are using the network. It also takes into account how much data you've downloaded in the past six hours.

» There may be times when if you want to download a large number of photos, you have to wait six hours for the download to complete. Then, the transfer will resume automatically.

» We'd be surprised if this were to affect anyone browsing their pictures online, which is how we'd recommend using any online service for photo storage.

» Transferring your photos to the cloud and not keeping a local copy or backup is risky, because you only need to get locked out of your account to lose years of memories. We advise keeping your photos on a local hard drive for everyday use and uploading a copy to the cloud for safekeeping.

» If you're an Amazon Prime member, you could take advantage of the free unlimited storage for high-resolution photos for as long as you keep your account (for non-Prime members, storage is capped at 5GB, as it is with the free version of OneDrive). You can sign into Amazon Photos at tinyurl.com/5wda7s9c.

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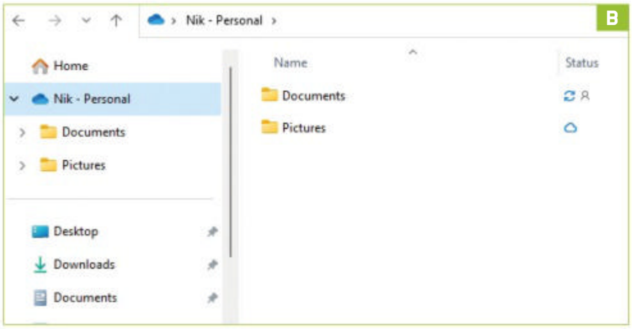


3 EXPORT YOUR PHOTOS FROM ONEDRIVE

Wherever you want to move your photos to, your first step is to export them from OneDrive. The easiest way to do this is to sync your online folders to your local PC. That way, your photos will be copied to your local Pictures library, from which you can upload them directly to your new online-storage service.

» Open File Explorer and look for your OneDrive account in the sidebar [**Image B**]. Expand yours by clicking the arrow to the left of its name, and check that the Pictures folder appears.

» To sync your PC and OneDrive Pictures folders, click the OneDrive icon on the Windows taskbar, then click the cog at the top of the pop-up window, followed by Settings. Click 'Account' on the left [**Image C**], followed by 'Choose folders' in the main part of the window. Tick the box beside Pictures and any other OneDrive folder that you want to synchronize to your PC. Click OK, and Windows will download their contents from the cloud.

» If you're not logged into OneDrive on your PC, you can download your photos through your browser. Log in at www.onedrive.com and click Photos in the sidebar. Next, hover over your most recent photo, and a small circle will appear in the top-right corner. Click this to select the photo without opening it.

» Scroll to the end of the library and hold Shift while hovering over the last photo. All the other photos that fit into the window will be shaded, and a circle will appear on the last one—click in it. Click the Download link that appears in the floating bar at the top. Your image library will be compressed and downloaded.

4 UPLOAD YOUR PHOTOS TO MEGA

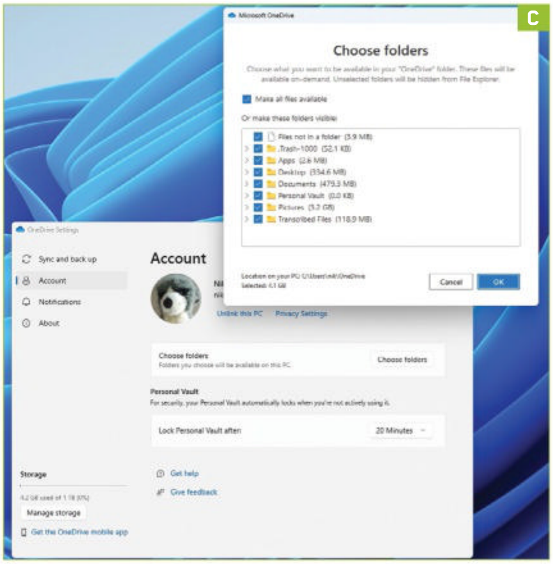
Like OneDrive and Dropbox, Mega has its own app, which synchronizes files between your computer and the cloud. Download it by clicking 'Download MEGA Desktop App' from mega.io/desktop. Once it's downloaded, launch the 'MEGAsyncSetup64' file from your Downloads folder [**Image D**], and leave the options in their default settings. Leave the option to 'Run MEGAsync 4.9.6' (or later) selected and click Finish.

» If you've already created a Mega account through the website, click 'Log in' and provide your credentials. If not, click 'Create account' and enter the required information. It will send an email to your inbox—click the 'Activate account' link it contains.

» Log in using the credentials you provided during installation, and Mega will create the encryption keys for your account before showing you the membership options. Scroll down and click 'Get Started for Free'. Mega will take a moment to build a file list, then show your account-recovery key, which you'll need if you forget your password. Click the green Download button, and save it.

» Return to the Mega setup assistant and log in using the credentials you just confirmed. It will ask which folders you want to synchronize. Click 'Selective sync', followed by Next. On the following screen, click Change on the line next to 'Local folder', and navigate to your Pictures folder in the File Explorer window.

» Be careful if you have set OneDrive to synchronize your Pictures folder, as you may have two of these: one in your user folder, and one inside your OneDrive folder. You want to use the former of these to avoid uploading another copy of your photos to your OneDrive account.



Choose what you want to be available in your "OneDrive" folder. These files will be available on-demand. Unselected folders will be hidden from File Explorer.

☑ Make all files available

Or make these folders visible:

- ☑ Files not in a folder (3.9 MB)
- ☑ .Trash-1000 (52.1 KB)
- ☑ Apps (2.6 MB)
- ☑ Desktop (334.6 MB)
- ☑ Documents (479.3 MB)
- ☑ Personal Vault (0.0 KB)
- ☑ Pictures (3.2 GB)
- ☑ Transcribed Files (118.9 MB)

Selected: 4.1 GB

Choose folders: Folders you choose will be available on this PC.

Personal Vault: For security, your Personal Vault automatically locks when you're not actively using it.

Lock Personal Vault after: 20 Minutes

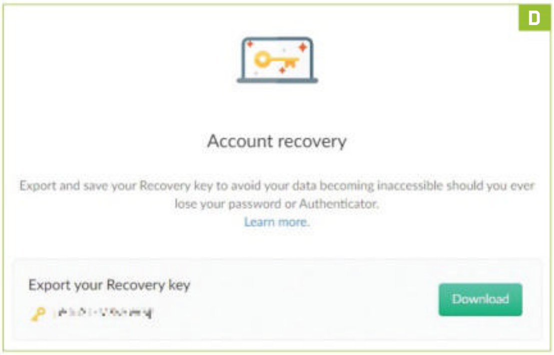
» Click Local Disk in the sidebar, followed by Users in the window. Click your name, followed by Pictures. Click 'New folder' above the sidebar, and call the new folder 'mega'. Double-click the new folder, then Select Folder. Click 'Next' in the Setup assistant window, then Finish.

» Open File Explorer. If you downloaded your photos from OneDrive through the browser, navigate to your Downloads folder, then unzip the OneDrive archive containing your photos. Open the folder. If you're syncing your photos to your PC, navigate to the Pictures folder in the OneDrive section in the File Explorer sidebar.

» Whichever folder you're in, select all the files (Ctrl+A), then copy them (Ctrl+C). Scroll down the sidebar until you find 'mega', then click it and press Ctrl+V to paste a copy of your photos into it. They will be uploaded to the Mega servers in the background.

» While you can open your synced photos via File Explorer, you can also access them remotely through the browser. Switch back to www.mega.io in your browser and click Photos in the sidebar to find the photos you've uploaded. If you do this too quickly, you may find they're still uploading, so don't worry if they don't all show yet.

» To create an album for related photos, click Albums, then 'New album'. Give it a name, and Mega will ask which photos to add. Click on the images, then click the green button marked Add. ⏻



Export and save your Recovery key to avoid your data becoming inaccessible should you ever lose your password or Authenticator.

LAB NOTES

JEREMY LAIRD, CONTRIBUTOR

Valve gets it right. Again

The Steam Deck OLED is almost perfect

AT RISK OF SOUNDING like a fanboy, I wasn't surprised when the updated Steam Deck appeared. The changes for the revised model were near exactly what I would have specified had you asked me to list them.

Valve is one of the few companies that has a fairly purist approach to product. By that, I mean the company isn't driven by marketing guys dreaming up ruses, then giving the engineering guys as little money as possible to come up with something that they can just about get away with selling.

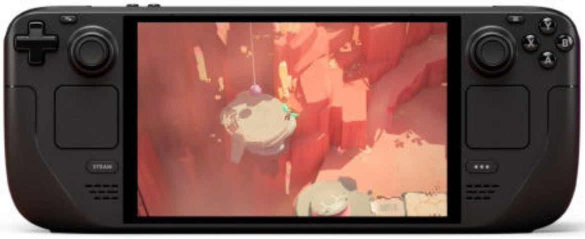
Instead, Valve is product driven, making the best product they can, and more or less let the marketing take care of itself. This is an interim product, so it makes sense to keep the outside the same and maintain backwards compatibility with cases and peripherals. So that's what they did.

Similarly, the Deck's console-like status means it's problematic to substantially improve performance. They just made the APU a little cheaper to make and a bit more efficient. Add a slightly better battery, and you get better battery life. A game that runs well on the new Deck will run pretty much the same on the old Deck.

Then there's the screen, obviously the biggest change. I've had a play, and the OLED panel doesn't disappoint. The old LCD panel was its weakest feature, so the OLED with its genuine HDR is a revelation.

Valve has made the screen larger by reducing the bezel size. Apart from giving you a bigger screen, it makes the Deck look more contemporary, despite being essentially the same object.

At this point, you're probably doubting my ability to cast a critical eye. But it is not perfect, and ironically, the most obvious problem involves the new Deck's best feature. Yep, it's the screen. Valve has covered it in etched anti-glare glass. It's great for reducing reflections, but it also robs the OLED panel of perceived contrast and makes all the black tones look a bit washed out. Using a stick-on screen protector helps, but I'd prefer the option of a factory-fitted plain glass cover.



SAM LEWIS

Staff Writer

I've been fluctuating between both Nord and ExpressVPN for a while now. In the past, the choice between the two has typically come down to which one had a better available offer at the time of purchase, as when we have put them directly head to head on previous occasions, they both proved to offer a very similar and impressive service. However, ExpressVPN's latest update managed to unveil further protection against quantum computing. These 'post-quantum protections' are set by default across all of its Android, iOS, Linux, Mac, and Windows applications.

As quantum computing becomes more readily available to the wider population, so too does the risk of us coming under attack from such power. They can process at unfathomable speeds compared to regular PCs, and this includes breaking into encrypted layers. It's a sad world that we live in, right?

Anyway, with ExpressVPN taking action, it looks like we are now on the right track when it comes to preventing such terrors from prevailing. Of course, quantum computing is hardly a household piece of technology, but it's nonetheless always best to stay one step ahead. Ultimtely this has swayed me once again to stick with Express for now.

© STEAMDECK

LG UltraGear™

LG's latest 4K gaming panel is much better in reality than on paper.

Editor's Pick:
LG UltraGear 27GR93U

Let's begin with the sordid matter of money.

THE CHEAPEST you can currently acquire the new LG UltraGear 27GR93U for is $630. That's quite a lot for a 27-inch gaming monitor, even if this new LG is the full 4K and knicks out 144Hz.

It's notable that the 32-inch version of this panel, the LG UltraGear 32GR93U, goes for about $750. It's more money, but if you're spending $630, there's a chance that you can afford $750. If it's not stretching that line of thinking to breaking point, at $800 you can grab a 27-inch 1440p OLED gaming panel.

We've seen the cheaper version of Alienware's 34-inch ultrawide OLED go for $800. Of course, there are 28-inch 4K gaming panels with 144Hz refresh available from proper brands for as little as $400. Those monitors use an Innolux IPS panel that isn't as good as LG's IPS tech, but then they're an awful lot cheaper.

Anyway, the overarching point is that the LG UltraGear 27GR93U's price tag puts you in a part of the monitor market that gives you a lot of options.Initial impressions aren't that good. Apart from the fact that the spec list is pretty modest in some regards, most obviously in terms of very limited HDR support, the 27GR93U feels pretty cheap and insubstantial as you pull it out of the box and piece it together, but don't panic. The good stuff happens when you actually fire the 27GR93U up.

This is a really lovely monitor, really, really lovely. On paper, it's just another IPS panel with pedestrian numbers like 1,000:1 contrast and HDR400 certification, and thus no local dimming and very limited, if any, true HDR capabilities.

Okay, the 1ms response is pretty much cutting edge for an LCD monitor, and the 95 percent coverage of the DCI-P3 gamut is decent, though hardly spectacular. But on paper, the LG UltraGear 27GR93U isn't much of a head turner. Heck, it doesn't even have USB-C, which admittedly isn't a major omission for a gaming monitor. It does have two proper HDMI 2.1 48Gbps ports, plus DisplayPort, however.

Anyway, if there's such a thing as a basic 144Hz 4K gaming monitor by the numbers, this is it. Yet, it's actually pretty stellar. For starters, it's beautifully calibrated. The colors are bang on out of the box, accurate and rich with plenty of pop but without being oversaturated or cartoonish.

Like any 27-inch 4K panel, it's razor sharp with fantastic pixel density. Nor will you be disappointed by the pace—unless you're a esports freak used to a 360Hz panel running *Counter-Strike* at 1080p. 144Hz is enough for most of us in terms of latency and smoothness, and the LG's pixel response is excellent. There's real clarity, even when ripping that mouse around viciously.

HDR is surprisingly usable, too. Primarily, this is because SDR content still looks great in HDR mode, which often isn't the case on low-end HDR monitors. Toggle HDR, and you're done. Actual HDR content like, say, *Cyberpunk 2077* with all the bells and whistles looks good in SDR terms rather than being terribly, er, HDR-y. But since SDR content doesn't suffer, you could just leave Windows in HDR mode and save you toggling it for specific games.

In summary, this is a darn fine monitor. For sure, it would be easier to really love it at, say, $500. But if you appreciate the eye-popping pixel density, and you're not bothered about having local dimming and something that comes closer to true HDR support, stick this new LG near the top of your shortlist. It's really, really nice **–JL**

$630, www.lg.com

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INTEL® CORE™ i9
i9-14900K
SRN48
X330K254
e4

This is a good value high-end CPU, but then so is its cheaper predecessor.

Intel Core i9 14900K

Fast, powerful, and just a bit boring

FOR THE FASTEST CHIP ever to grace a gaming PC, the Intel Core i9 14900K is about as boring a CPU refresh as one could be. We've seen it all before: the massive core count, the architecture, the 6GHz clock speed. The 14900K might do some things better than the 13th Gen, but it rarely matters. That doesn't make it any less of an awesome gaming chip—it just doesn't push the needle forward much.

The 14900K struggles to deliver anything new. It's marginally faster than its predecessor, the 13900K, though its minor improvements do not deliver significant improvement in games. You may see marginally bigger numbers in synthetic benchmarks, but those are the only times you're going to feel that performance boost.

The important factor is price. The 14900K is no more expensive than the 13900K was at launch, and will make for an almost like-for-like replacement. The tricky bit is that for the time being, the 13900K remains the cheaper chip, as prices have dropped since its release. For the moment, the cheaper 13900K still gets my recommendation.

As the flagship processor of a refreshed Raptor Lake generation, the 14900K is almost a carbon copy of the Core i9 13900KS You're looking at a 24-core processor, split between eight Performance-cores (P-cores) and 16 Efficient-cores (E-cores). Each of those P-cores has access to 2MB of L2 cache, and each E-core cluster (four E-cores sharing a common cache) has access to 2MB. In total, that's 32MB of L2 cache across the entire chip.

The iGPU present on the 14900K (not found on the 14900KF, or any chip denoted with the KF or plain F suffix) is the UHD Graphics 770. Unlike the new Arc Xe-LPG iGPU found on Intel's new Meteor Lake mobile processors, this iGPU doesn't pack the punch required of it for 1080p gaming in lieu of a discrete graphics card.

You can use both 600-series and 700-series motherboards with this processor. Naturally, Intel would recommend a Z790 board for the maximum power delivery, alongside a 360mm cooler, although you can get away with less. I've been testing the 14900K with the same Asus ROG Strix Z690-F Gaming Wifi motherboard I've used across the entire LGA 1700 lineup, and it has worked great.

Naturally, this means you can stick with a DDR4-compatible motherboard with the 14th Gen. This will surely be the last chip generation to make this offer, however. Intel officially supports up to DDR5-5600 or DDR4-3200, though you can often run faster kits without issue.

The 14900K is often the fastest gaming CPU in benchmarking. It tops the charts in *Metro: Exodus*, *Far Cry 6*, and *Shadow of the Tomb Raider*, and that's without going beyond what my motherboard considers stock power limits.

The kicker is that it's only marginally faster than the Core i9 13900K, and often no quicker at all. In *F1 2021* and *Far Cry 6*, the 14900K made the biggest gains, but there are just as many titles in which these two chips are neck-a-neck. It's not a convincing leap in gaming performance, unfortunately.

The 14900K shows its best performance in non-gaming benchmarks. It's mostly in the more traditional benchmarks that you see the benefit of mildly increased clock speeds. It's the fastest gaming CPU we've ever run through the X264 encoding benchmark, nearly knocking AMD's Ryzen 9 7950X3D off the top spot in Blender.

It's performance in these sorts of intense workloads that you need to care about to justify buying the 14900K. Otherwise, just get a 14600K—it's almost as good for gaming, and still a great runabout for multitasking and editing.

The Core i9 14900K, then—boring, but not bad. A gaming CPU built on the shoulders of other really great gaming CPUs—what matters most is that you can hit high frame rates, encode video, build a house in Blender, and stream to your adoring fans all at once. With this high-end CPU, you can, though that's as true of the previous top Raptor Lake chip as it is this one. **–JACOB RIDLEY**

VERDICT

8

Intel Core i9 14900K

⊞ **METEOR LAKE** Great single-threaded and multi-threaded performance; Works wonders with a high-end graphics card; Compatible with 600/700-series motherboards.

⊟ **MINOR LEAGUE** Doesn't improve on the Core i9 13900K by much, if at all; Large CPU cooler almost essential; Still can't match AMD 3D V-Cache chips in some games; Nothing new of note.

$589, www.intel.com

BENCHMARKS

	Core i9 14900K	Core i9 13900K	Ryzen 9 7950X3D
Metro Exodus (fps)	**139**	**139**	134
Total War: Three Kingdoms (fps)	**217**	**217**	216
F1 2021 (fps)	200	194	**218**
Far Cry 6 (fps)	**187**	182	183
Shadow of the Tomb Raider (fps)	**225**	**225**	221
PCMark 10 Express (Index)	**7,636**	7,316	7,190

Best scores are in bold. Our Intel test bench consists of an Asus ROG Strix Z690-F Gaming WiFi, 2TB Sabrent Rocket 4.0 Plus, Asus ROG Ryujin II, Gigabyte Aorus P1200W. Our AMD test bench consists of an ASRock X670E Taichi, 1TB WD Black SN850, Corsair H100i RGB and NZXT 850W. Both machines shared an Nvidia GeForce RTX 3080 10GB and G.Skill Trident Z5 Neo DDR5-6000 CL30 2x 16GB. All tests were done at 1080p resolution at highest or ultra settings.

SPECIFICATIONS

Cores (P+E)	8+16
Threads	32
L3 Cache (Smart Cache)	36MB
L2 Cache	32MB
Unlocked	Yes
Max PCIe lanes	20
Graphics	UHD Graphics 770
Memory support (up to)	DDR5 5600MT/s, DDR4 3200MT/s
Processor Base Power (W)	125
Maximum Turbo Power (W)	253

INTEL CORE™ i5
i5-14600K
SRN43
L334D919

The 14600K is a minor upgrade, but it's hard to beat at this price.

Intel Core i5 14600K

The new best mid-range gaming CPU

THE K-SERIES CORE I5 is usually the easiest recommendation from any new Intel generation. I'm less sure of the Core i5 14600K. On the one hand, this new chip is a couple of frames faster than the Core i5 13600K it replaces, and remains extremely competitive versus AMD's mid-range. On the other, it's a touch more expensive than the 13600K, and paying extra for near enough the same thing doesn't feel great, though that's mostly because the older chip is discounted on its way out the door.

Due to Intel's decision to stick with a largely unchanged Raptor Lake architecture for the 14th Gen—the same used throughout most of the 13th Gen—there are few differences between the Core 14600K and 13600K. That includes the launch price, which remains at $329. After one year in the market, however, the 13600K is no longer selling at Intel's recommended customer price. I've found it for as little as $310.

The Core i5 14600K features six Performance-cores (P-cores) and eight Efficient-cores (E-cores). That's a total of 14 cores with 20 available threads. With 24MB of L3 (Smart) cache and 20MB of L2—2MB for every P-core and 4MB for each of the two E-core clusters, it's an exact match for the 13600K.

The 14600K is faster than its predecessor, however. Not in terms of highest clock speed—this is rated to 5.3GHz Max Boost, same as the 13600K—but the P-cores are up to 200MHz faster, and the E-cores 100MHz faster.

Most often these faster clocks amount to a small increase in frame rates over the 13600K. That's a frame or two on average, though there are still games where the 14600K doesn't benefit at all from its minutely faster clocks, such as *F1 2021*.

Even a frame or two is within reasonable testing variance ranges. The only reason it's clear that there is some benefit to the 14600K over its predecessor is that it's pretty consistently ahead across multiple runs and benchmarks.

In synthetic benchmarks, there's even less to report from my testing. The Core i5 14600K holds a perfunctory lead over the 13600K, which amounts to no serious real-world benefit. You can also expect a slightly higher power consumption on the 14600K. I put it at around 10W higher peak wattage during testing.

The more interesting fight is between the 14600K and AMD's lineup. You've got the Ryzen 7 7800X3D at $395, which comes with 3D V-Cache to boost frame rates in games that benefit most from more cache close at hand, or the cheaper Ryzen 7 7700 at $323, which doesn't.

The 14600K and 7800X3D are in a dead heat across the games I've used for benchmarking, each chip with three titles under its belt. When AMD's 3D V-Cache does work, however, it works wonders. Take *F1 2021*, for example. Clearly there's more to gain from AMD's 3D V-Cache, when it's really working hard, but AMD's chips start out a lot more expensive for its inclusion.

In synthetic performance benchmarks, it's Intel's higher overall core counts and strong P-core performance that help it maintain a solid lead. In Cinebench R23, Intel's mid-range chip dominates AMD, and even in encoding or rendering benchmarks like X264 or Blender I saw the 14th Gen chip pull ahead.

The downside of the 14600K is that it's a whole lot more power hungry than AMD's Ryzen 7, consuming double the wattage at peak load. Intel does net the benefit of being a cheaper upgrade for a builder with an LGA 1700 motherboard already in their machine, however.

I'm prepared to call this race in favor of Intel's Core i5 14600K. Where AMD can often claim high-end gaming dominance, its mid-range and budget chips are often worse value versus Intel's, though if you must chase the best-value chip, I dare say it's still the last-gen 13600K that gets my vote.

The Core i5 14600K isn't as easy of a recommendation as the Core i5 13600K that came before it, simply because it exists today as a slightly more expensive version of that excellent chip without much else to show for it. Yet this Core i5 remains a great value pick versus AMD's 7000-series chips. **–JACOB RIDLEY**

VERDICT
8

Intel Core i5 14600K

+ WORTHY UPGRADE A superb all-rounder; Nominally better than the 13600K; Excellent gaming performance.

− SAVE YOUR CASH We've seen this chip before; Power hungry.

$329, www.intel.com

BENCHMARKS

	Core i5 14600K	Core i5 13600K	Ryzen 7 7800X3D
Metro Exodus (fps)	**137**	**137**	134
Total War: Three Kingdoms (fps)	215	214	**217**
F1 2021 (fps)	196	196	**220**
Far Cry 6 (fps)	177	175	**178**
Shadow of the Tomb Raider (fps)	**225**	223	223
PCMark 10 Express (Index)	**7,278**	7,132	6,900

Best scores are in bold. Our Intel test bench consists of an Asus ROG Strix Z690-F Gaming WiFi, 2TB Sabrent Rocket 4.0 Plus, Asus ROG Ryujin II, Gigabyte Aorus P1200W. Our AMD test bench consists of an ASRock X670E Taichi, 1TB WD Black SN850, Corsair H100i RGB and NZXT 850W. Both machines shared an Nvidia GeForce RTX 3080 10GB and G.Skill Trident Z5 Neo DDR5-6000 CL30 2x 16GB. All tests were done at 1080p resolution at highest or ultra settings.

SPECIFICATIONS

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L2 Cache	20MB
Unlocked	Yes
Max PCIe lanes	20
Graphics	UHD Graphics 770
Memory support (up to)	DDR5 5600MT/s, DDR4 3200MT/s
Processor Base Power (W)	125
Maximum Turbo Power (W)	181

crucial
by Micron
T700
PCIe® Gen5 NVMe™ M.2 SSD

The fastest SSD, but most should stick with PCIe 4.0 for now.

Crucial T700

The fastest consumer SSD you can buy

THE CRUCIAL T700 sets a new bar in performance for consumer SSDs, pushing speed higher than any other PCIe 5.0 NVMe drive on the market. It reigns as the king of the hill for sequential bandwidth and random IOPS, at least for now. Its native DirectStorage firmware optimization is an added benefit over almost all PCIe 4.0 SSDs for future gaming. Crucial departs from the reference heatsink design with its own solution, while also offering a cheaper, bare-drive variant for easier installation with motherboard and custom M.2 heatsinks. Together, this makes it a great option for enthusiasts and early adopters.

The T700 is part of a wave of PCIe 5.0 SSDs about to deluge the consumer SSD market, all based on the same Phison E26 controller and Micron flash. Competing controllers are on the way with InnoGrit's IG5666 and SMI's SM2508, and flash of the 232-Layer generation should be in wider production from Micron and other manufacturers. Faster drives based on the Phison E26 SSD Controller have also been announced, offering up to 14 GBps, so early drives like the T700 have a limited window. Many of these won't be available until later in the year, but this drive is currently the fastest of its crop.

The Crucial T700 is available at 1TB, 2TB, and 4TB capacities in bare and heatsinked variants. Paying $30 extra for the small metal heatsink is asking too much. If you have a motherboard with a decent M.2 heatsink, you should get that model. The included heatsink works fine in our testing, but a $10 premium would be more in line with what you're getting.

The T700 is capable of reaching 12,400 MBps/11,800 MBps for sequential reads and writes and 1,500 million IOPS for both random reads and writes. The main benefit over slower PCIe 5.0 SSD variants is the sequential performance increase, but write IOPS are also higher. Crucial warranties this drive for the typical 600TB written per TB of capacity at up to five years. It also offers its own SSD toolbox, called the Crucial Storage Executive, which includes drive information, SMART attributes, firmware updates, secure erase/sanitize, overprovisioning, and other features related to encryption.

ON TEST

The T700 is the fastest drive we've tested to date in 3DMark. The performance improvement over other PCIe 5.0 SSDs is 4-7 percent, with a larger gap between the T700 and leading 4.0 options. Speaking of gaming, this comes with DirectStorage optimization, which is only available on one PCIe 4.0 SSD, the Sabrent Rocket 4 Plus-G. PCMark 10 shows a similar pattern, with the T700 again on top. The real-world differences between the top drives are small, especially among the PCIe 5.0 models, but the slightly higher transfer speeds push Crucial to the top.

Using the version of the T700 that includes a heatsink during the write saturation testing, it reached a peak temperature of 87C on the controller. At that point, it begins throttling. A larger heatsink and/or direct active cooling can reduce temperatures. With a large Asus heatsink, peak temperatures during our Iometer testing only reached 54C. In terms of power consumption, the T700 pulls a lot of power and is less efficient than even the fastest PCIe 4.0 drives.

As for the PCIe 5.0 selling point, the results speak for themselves: for anything but sequential bandwidth, you should go for a much cheaper PCIe 4.0 SSD. Even on a PCIe 5.0 capable board, getting a drive that performs similarly aside from sequential speeds while being much more efficient makes sense—and many 4.0 drives don't require a heatsink. The Crucial T700 is the fastest SSD we've tested, but if you aren't hell-bent on cutting-edge storage, you should stick with drives like the Solidigm P44 Pro or WD Black SN850X. **–SHANE DOWNING**

VERDICT **8**

Crucial T700

+ HIGH-5.0 High all-around performance; Fastest to date; DirectStorage-optimized firmware.

− LOW-5.0 Early adopter product with incoming competition; Much higher price relative to fast PCIe 4.0 SSDs; Only modest real-world performance gains; Optional heatsink only satisfactory.

$340 (2TB, version tested), $180 (1TB), $600 (4TB), www.crucial.com

BENCHMARKS

	Crucial T700 2TB	Samsung 990 Pro 2TB	Sabrent Rocket 4 Plus-G 2TB
3DMark Storage (Score)	**5,613**	4,816	4,289
PCMark 10 Storage Bandwidth (MB/s)	**857**	743	556
PCMark 10 Latency (μs)	**31**	36	51
PCMark 10 Storage (points)	**5,480**	4,651	3,331
DiskBench 50GB File Folder Copy Transfer Rate (MB/s)	**2,601**	1,842	1,906
DiskBench 50GB File Folder Write Transfer Rate (MB/s)	**2,858**	1,905	1,906
DiskBench 6.5GB Zip File Read Transfer Rate (MB/s)	**4,887**	4,024	4,019

Best scores are in bold. Our test bench consists of an Intel Core i9 12900K, Asus ROG Maximus Z790 Hero, 2x16GB G.Skill DDR5-5600 CL28, Sabrent Rocket 4 Plus-G 2TB (OS), and Windows 11 Pro.

SPECIFICATIONS

Variants	Bare, Heatsinked
Form Factor	M.2 2280
Interface / Protocol	PCIe 5.0 x4
Controller	Phison E26
DRAM	LPDDR4
Flash Memory	232-Layer Micron TLC
Sequential Read	12,400 MBps
Sequential Write	11,800 MBps
Random Read	1,500K
Random Write	1,500K
Endurance (TBW)	1,200TB
Part Number	CT2000T700SSD3/5
Warranty	5-Year

AMD's mobile chips supply gaming prowess in a tiny chassis.

Framework 13 (2023) AMD Mainboard

Style, customization, and gaming power

THE NEW FRAMEWORK AMD mainboard is finally here, and now I love the Framework 13 laptop. I've liked previous versions of this upgradeable portable PC, but while it's a good office laptop, it never really sung to me as a device. Dropping the new AMD Ryzen 7 7840U board into this old chassis, however, has made me fall in love with this laptop in a way none of the Intel upgrades ever did.

My first experience with this laptop was as a Tiger Lake-based system with an 11th Gen Intel chip inside it, and it was fine. The 13-inch scale is great for a predominantly office-focused notebook—the design is slim and simple, the modular ports are great, and I love the 16:10 aspect ratio of the sharp, glossy 2256 x 1504 resolution screen.

But it's never been a laptop for a PC gamer. Even after replacing that mainboard with a newer 12th Gen Alder Lake, and more recently a 13th Gen Raptor Lake board, those updates only made it a better office machine. I'm not saying that with the new AMD Zen 4 mainboard upgrade, this is suddenly a rare 13-inch gaming laptop, but it's certainly a laptop that's now got game.

AMD makes all the best mobile chips right now, and this Ryzen 7 7840U chip highlights the red team's dominance. The 7840U is the beating heart of the best handheld gaming PCs of this generation.

Yes, the Steam Deck is the gateway drug for handhelds, but it's the current crop that have made genuine mobile PC gaming a possibility, and that's because of the RDNA 3 compute units at the heart of this stellar APU, and the fact that there are 12 of them.

That GPU power translates here to the Framework 13, giving it genuine 1080p gaming performance at Medium, and sometimes even High graphics presets—even more so if you're playing games with AMD's FSR upscaling tech at play, or even Intel's agnostic XeSS. That includes a lot of modern PC games right now.

PROS AND CONS

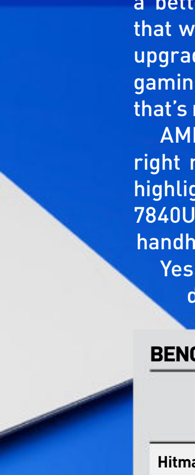
What isn't included in many games today is AMD's new Frame Generation technology that sits alongside its FSR 3 rollout, which is a shame. I've tested it in *Forspoken*, and you're looking at a huge boost in gaming frame rates from enabling both FSR 3 and AMD's Frame Gen feature. It's a game changer for the handheld market, and the same goes for this laptop here. I hope developers really get on board with AMD's lighter touch and broader approach to frame interpolation.

Upscaling and magic frames aside, the hardware is still effective at native settings if you're a little parsimonious about your image presets. However, it's not as quick in gaming terms as the handhelds I've tested with the same APU. It's often only a few frames per second behind the ROG Ally or OneXFly, but those gaming devices do have an edge.

The CPU performance also impresses; this is an eight-core Zen 4 CPU, with a full 16 threads of processing power and a heady measured 4.9GHz clock speed in this svelte chassis. That means it's a pretty monstrous processor that would have been high-end desktop level just a few short years back.

It's not perfect, however. The trackpad sometimes is a little finicky when it comes to finding the right-click sweet spot, and I'd kill for a glossy version of this 16:10 screen with a refresh rate higher than 60Hz. It will get loud at the full 30W TDP mode of the Ryzen chip when gaming, too. Thankfully, that is only when you're pushing it to its max, because otherwise the system is whisper quiet.

The new AMD mainboard gives this the gaming prowess of a modern handheld PC and greater power and efficiency than the far more expensive Intel Framework boards, too. This is the pinnacle of Framework's 13-inch design, possibly the ultimate hybrid gaming ultrabook, and a laptop I now have genuine affection for. **–DAVE JAMES**



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BENCHMARKS

	Framework 13 AMD	Framework 13 Intel 13th Gen	Asus ROG Ally
Hitman 3 Dubai (Native 1080p) (Avg. fps)	43	30	**48**
Horizon Zero Dawn (Native 1080p) (Avg. fps)	27	16	**30**
Cyberpunk 2077 (Optimized 1080p) (Avg. fps)	**37**	N/A	**37**
F1 22 (Optimized 1080p) (Avg. fps)	**76**	N/A	73
Hitman 3 Dubai (Optimized 1080p) (Avg. fps)	59	N/A	**66**
Horizon Zero Dawn (Optimized 1080p) (Avg. fps)	62	N/A	**66**
Metro Exodus Enhanced Edition (Optimized 1080p) (Avg. fps)	19	N/A	**21**

Best scores are in bold.

VERDICT **9**

Framework 13 (2023) AMD Mainboard

+ **MAINFRAME** Genuine 1080p performance; Stellar productivity chops; Cheaper and faster than Intel's best; Better battery life.

− **FRAMEUP** Trackpad's a touch finicky; Needs a higher refresh screen; Loud when gaming.

$699 (mainboard only), www.frame.work

SPECIFICATIONS

Cores	8
Threads	16
Boost clock	5.1GHz
Memory support	DDR5-5600
PCIe support	PCIe 4.0
Graphics	AMD 780M
Compute units	12
Clock speed	2,700MHz

Raspberry Pi 5

Our favorite single-board computer gets an upgrade

THE RASPBERRY PI, the little single-board computer beloved of those for who 'electronics project' means more than replacing a lightbulb, is now on its fifth iteration. It's come a long way in that time, replacing a text interface with a full Linux desktop and even being able to run Windows if you ask it really nicely.

The fifth release takes things up a level. While the Raspberry Pi 4 was usable as a desktop computer if you stuck to low-power versions of Linux and SATA SSDs connected over USB, the Pi 5 offers as much as three times the processing power of its immediate predecessor, and has a 1x PCIe 2.0 interface that, with the appropriate add-on, could be used to connect an NVMe SSD. With 8GB of RAM, the potential for overclocking, and an active cooler on offer too, this puts it very definitely in low-end desktop territory, with a Geekbench 6 single-core score akin to that of an Intel Pentium G4400T from 2015 and a multi-core score that tallies with the Pentium G4620 from 2017.

So, not huge amounts of processing power, but enough for a web browser, office suite, and potentially more depending on the OS you choose. The Raspberry Pi OS itself is a fork of Debian Linux 12.2 (Bookworm), and there's a version of the latest Ubuntu 23.10 (Mantic Minotaur) release that's tuned for the Pi. The ARM version of Windows 11 wasn't out of reach for the Pi 4, so that could run well here if you can get hold of it, but it's the free OSes that really shine on the Pi, with RiscOS and Android available, as well as operating environments tuned for retro gaming (such as RetroPie) and media center use (including Kodi).

The extra power over the Raspberry Pi 4 makes itself known. Apps open twice as quickly just from the SD card, and we expect them to move even faster from an SSD. It also streams more smoothly, with 1080p YouTube videos dropping far fewer frames than on the previous Pi, though playing a 1080p video with the screen resolution set to 4K is still choppy.

The new Pi also includes a custom chip, designed in-house, that handles the I/O for the board. This RP1 has the effect of doubling the USB bandwidth over previous models (individual USB 3 ports still top out at 5Gbs, but you can use more of them at the same time), and allows for a faster Micro SD reader and MIPI camera/display connectors. There's also a PCIe connector on board, but you'll need a not-yet-released HAT (the add-on boards Pi computers use to add functionality) to put an SSD in it. There are four PCIe 2.0 lanes on the Pi 5, but only one is exposed to the user. This means SSDs won't be super fast, but they should still outstrip your other options.

And while the board is still capable of running naked, there's an official active cooler available for the first time that you'll definitely want if you're going to explore overclocking. There's a higher power requirement too, both for if you want to power peripherals (beyond a mouse and keyboard) from the board and use its processors at their peak. This means you may need a new power supply—a 27W unit is available for $12—and you'll also need a new case, as the Ethernet and USB ports have switched places on the updated board, while the composite video output has been deleted.

Otherwise, this is the same credit-card-sized computing board we've been using in homebrew projects for years—just more powerful and capable. Bring it on. **–IAN EVENDEN**

VERDICT
9

Raspberry Pi 5

⊞ **RASPBERRY FLY** Mightier and more accomplished; Just as cheap.

⊟ **RASPBERRY CRY** Hardware and software support not perfect at launch.

$80 (8GB model), raspberrypi.com

SPECIFICATIONS

CPU	Broadcom BCM2712, 4x Arm Cortex-A76, 2.4GHz
RAM	1-8GB LPDDR4X
GPU	VideoCore VII
Storage	Micro SD, USB, PCIe
Connectivity	2x USB 2, 2x USB 3, 1x USB-C (power), PCIe 2.0 x1, Wi-Fi 5, Bluetooth 5, Ethernet, 2x Micro HDMI, 40-pin GPIO, 2x MIPI, UART
Dimensions	85 x 56mm
Weight	46g

The 8GB memory makes this a usable desktop computer.

HP Omen 16 (2023)

Luxurious, but expensive and underpowered

THE HP OMEN 16 finds itself surrounded by a multitude of 16-inch premium gaming laptops featuring Nvidia GeForce RTX 4080 GPUs. However, it takes more than having a powerful 40-series GPU to stand out in this competitive market, particularly in the higher price range of over $2,000. You still need the performance to back it up.

This HP Omen 16 is a top-of-the-line 16-inch gaming laptop with an Intel Core i7 13700HX processor. For memory and storage, you're looking at 32GB DDR5-4800 RAM and a 2TB NVMe SSD (in some territories that's 1TB). Currently, it is available at a discounted price of $2,359 on the HP website, but without the discount, the system would cost $2,790.

The HP Omen 16 boasts a sleek and minimalist design that aligns with the trend among 16-inch laptops of a more toned-down gamer look. However, despite its powerful appearance, the system falls short in terms of performance, especially considering its high price point. On the CPU front, the Omen 16 delivers subpar performance across various synthetic and gaming benchmarks. It consistently ranked last in nearly every category, often significantly behind the Alienware X16.

The Core i7 chip inside here doesn't really compete with the Core i9 found on other laptops with a similar price point. Considering that this is the most powerful option you can choose for the HP Omen 16, you might have to look elsewhere if you're looking for the power of a workstation.

Regarding GPU performance, the Omen 16 fared slightly better, but still lingered towards the lower end of the gaming performance rankings compared to other premium 16-inch laptops featuring an RTX 4080. I consistently hit triple-digit frame rates when playing *Diablo 4* and Freelancer Mode in *Hitman: World of Assassination*, which is a plus.

IN-GAME PERFORMANCE

On the other hand, I encountered lots of stuttering in areas with many characters on the screen, like the crowded Miami level in *Hitman* or when monsters gather around you in *Diablo 4*. While nailing high frame rates is great, I'd trade that in for a smoother gameplay experience at a lower frame rate. Granted, I was playing these games at the highest settings—you could mitigate this by dialing down some settings, or using DLSS 3 to smooth out the experience, especially at 1440p.

The RTX 4080 housed within this device is listed as 145W, so it's expected not to reach top-tier performance like most of the other RTX 4080 laptops we've tested at 175W. However, considering its regular pricing, which is higher than the Acer Predator Helios 16 and only a little cheaper than the impressive Lenovo Legion Pro 7i, it raises concerns.

The HP Omen 16 is also very noisy. Thankfully, while you're playing games, even demanding ones like *Metro Exodus* or *Cyberpunk 2077*, it doesn't hit the same decibel level as the Alienware X16, but it still sounds like you're running a portable air conditioner at full blast.

Another drawback of the Omen 16 is the abundance of pre-installed software. With applications such as Dropbox, McAfee Security, Express VPN, and several HP-related software, it took me at least an hour to remove everything before I could do any benchmarking.

HP Gaming Hub offers useful features for diagnostics and optimization, but its slow game launcher and cumbersome interface detract from its utility. The RGB keyboard presets are fun, though. This specific configuration of the Omen 16 includes a complimentary HyperX Cloud II Core Wireless Headset. One neat feature of this headset is it's pre-paired with the laptop right out of the box, eliminating the need to do it yourself. It offers decent wireless performance and battery life, and the microphone isn't bad, either.

The HP Omen 16 laptop itself, however, fails to deliver the expected level of performance and value when compared to its counterparts in the 16-inch RTX 4080 laptop category. It falls short because of its lackluster CPU and GPU performance, higher price point, bloatware issues, and subpar gaming experience. Not a great combo, for sure. **–JORGE JIMENEZ**

VERDICT
6

HP Omen 16 (2023)

+ PROPHETIC Slim, minimalist design; Comes with a decent wireless headset; Speedy 240Hz IPS panel.

– PATHETIC Tons of bloatware; Lackluster CPU/GPU performance; Loud fan noise.

$2,359, www.omen.com

BENCHMARKS

	HP Omen 16	Razer Blade 16	Lenovo Legion Pro 7i	Alienware X16 R1
3DMark Time Spy Extreme (CPU Index)	6,577	8,159	**9,128**	6,432
3DMark Time Spy Extreme (GPU Index)	8,240	**10,509**	9,134	9,022
Cyberpunk 2077 RTX (fps)	33	**42**	39	32
Horizon Zero Dawn (fps)	120	**132**	131	131
Metro Exodus Enhanced (fps)	71	86	88	**89**
3DMark Storage (Index)	2,572	2,129	3,074	**3,601**

Best scores are in bold. All other systems listed utilise a 175W RTX 4080 GPU, compared to the HP's 145W model. All game tests done at 1440p resolution with Ultra settings.

SPECIFICATIONS

CPU	Intel core i7-13700HX
Graphics	Nvidia GeForce RTX 4080
RAM	32GB DDR5
Display	16-inch, QHD+ (2560 x 1600) 240Hz
Storage	2TB M.2 PCIe NVMe SSD
Ports/ Connectivity	1x 3.5mm Combo Audio Jack, 1x HDMI 2.1, 2x USB 3.2 Gen 2 Type-C for display/power delivery, 2x USB 3.2 Gen 2 Type-A, Ethernet
Weight	2.44kg / 5.4lbs
Size	14.53 x 10.21 x 0.93 in

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The minimalist design is sadly matched by minimal performance.

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Be Quiet! Shadow Base 800 FX

The perfect case to house your new rig?

YOU'VE JUST SPENT what feels like years speccing out your new custom PC. On paper, it is a behemoth, ready to provide you with framerates higher than your eyes can comprehend. However, you've still not decided what chassis you should use. There are endless choices—you could even wall-mount it. Ideally, though, you need to pick a case that not only offers great aesthetics, but functionality and quality as well. A handful of brands come to mind, like Be Quiet. Is its Shadow Base 800 FX the one you need?

Be Quiet has a range of cases. As the name implies, this 800 FX falls into the Shadow Base range. These chassis aim to provide excellent airflow, and are typically one of its larger models. So straight off the bat, we wouldn't recommend building an ITX system in here unless you want enough excess space to start a whole new ecosystem as well. Yes, this is a very spacious cage—there's plenty of room in the interior, even with an E-ATX system inside. Not only does this help when building your PC, if you need to make any tweaks or improvements, there's room to do so. There's enough internal storage to fit radiators of up to 420mm in length, and certainly an RTX 4090 GPU.

Here, we have the white variant, and despite its size, it's sleek and modern. It features slim ARGB accents that give it that modern feel without being overkill. To cycle through preset color schemes, there's a dedicated button on top of the case. There's also an ARGB/PWM hub pre-installed where you can add more RGB devices. Further ARGB vibrance comes from the four included Light Wings White 140mm PWM fans. Again, these offer a slim ring of ARGB rather than the blades also being colored. It's the right amount, so you can quickly change the theme of your PC without it looking like a light show.

Speaking of the fans, they offer more than enough airflow into this large chassis. Out of the box, there are three at the front to pull in plenty of cool air in and over your motherboard and components. With large vented upper and rear panels, the warm air disperses with the help of the 140mm fan at the back. You'll find 120mm fans in most cases, but these 140mm provide a larger surface area and increase general airflow. Great airflow equals great cooling, so the Shadow Base 800 FX gets the thumbs up from us.

Another area of appraisal is ease of use—the panels can be pulled off with minimal effort. To remove the tempered glass panel and rear panel, loosen the thumbscrews towards the back and slide out. The front panel is removed by pulling gently from the bottom. You'll also find two magnetic mesh dust covers—one at the top, and one at the front.

Being a large case, there must be good cable routes to keep your build organized. Be Quiet offers lots of routes for both the PSU and motherboard cables to hide in with velcro tabs around the back for cable management. Touching on the PSU, this has an external bracket that you mount to your power supply before attaching it to the case. It's not conventional, but it works, and increases PSU compatibility. We all know how screw alignment for PSUs can be headache-inducing.

But the great features, design, and overall build quality of the case do come at a cost—just shy of $200. With a lot of cases being $50 to $100 cheaper than this, it does make you wonder if the Shadow Base 800 FX is worth the extra money. In our eyes, if you're building a top-end machine with vast AIO cooling and a hefty graphics card, then yes. As we said, the build quality is fantastic, it has a rewarding ease of use, and it should fit within most home environments due to its sleek aesthetic. **–SAM LEWIS**

VERDICT
9

Be Quiet! Shadow Base 800 FX

+ FORTRESS Strong airflow; Premium build quality; Clean design; Large internal space.

− CRACK IN THE WALL Heavy case; Slightly expensive.

$199.99, www.bequiet.com

SPECIFICATIONS

Form Factor	Mid-tower
Motherboard Support	Mini-ITX, Micro-ATX, ATX, E-ATX
Colors Available	Matte Black, Matte White
Window Available	1x Tempered Glass
Front I/O ports	1x USB 3.2 Gen 2 Type-C, 2x USB 3.2 Gen 2 Type-A, 3.5mm headset audio jack, LED control, I/O button.
Radiator Support	Front up to 420mm, Top up to 420mm, Rear up to 120mm
Fan Support	Front: 3x 120/140mm, Top: 3x 120/140mm, Bottom: 1x 120/140mm, Rear: 1x 120/140mm
Dimensions	21.6 x 20.5 x 9.7 inches
Weight:	27.11 lbs

© META

Meta Quest 3

The best VR headset just got a whole lot better

WHILE THE LOFTY dreams of an all-encompassing digital universe have yet to materialize fully, the Meta Quest 3 represents a recalibration of the metaverse vision proposed by Mark Zuckerberg. Instead of a dystopian portrayal akin to *Ready Player One*, it refers to the fundamentals: playful arm-waving, immersive gaming, and watching sports in VR. And honestly, that's perfectly fine.

The Meta Quest 2 was hands-down the best VR headset on the market, which has seen a lot of competition since then. The headset, released in 2020, has started to feel a little dated, as its once impressive Gen 1 Snapdragon XR2 was starting to feel like an ancient relic, especially against newer, fancier headsets.

The Meta Quest 3 is a massive upgrade from the Quest 2. It's more powerful, its stunning 4K+ pancake lenses make games look phenomenal, it boasts excellent inside-out tracking, and it has a fairly idiot-proof setup. On top of that, it's priced at only $500, making it one of the most affordable VR gaming headsets—or, I should say, "mixed reality headsets"—on the market.

The Quest 3 sports a 2,064 x 2,208 resolution per eye on pancake lenses, offers up to a 120Hz refresh rate, and provides a FOV of 110 degrees. It's powered by Qualcomm's 2nd gen Snapdragon XR2 chip, giving it at least double the graphical performance of the Quest 2.

The passthrough cameras are vastly superior to those in earlier versions (even better than the Meta Quest Pro), offering a clearer and higher-quality image. It's now much easier to read text on a phone or monitor—a double tap on the headset's side provides a detailed view of your surroundings. The depth adjustment buttons inside the visor are a blessing for those who wear glasses. They allow for an expansion of the visor, ensuring that your glasses aren't pressed against your face or the headset's lenses.

The Quest 3 now employs pancake lenses, similar to those in the Quest Pro. These slimmer lenses afford the headset a more streamlined profile than the Quest 2, even if it's roughly ten grams heavier. The weight distribution feels more balanced, making the headset more ergonomic. It's a compact, well-crafted device that doesn't strain your neck, even after prolonged use. I particularly noticed its comfort during virtual workouts; it never felt like my head was trapped, even after over an hour.

NEW TITLES

Meta gave me access to newer titles, such as the first-person rogue-like *Dungeons of Eternity* and the enhanced version of *Red Matter 2*, a sci-fi adventure. Both games would likely struggle running natively on the Quest 2. While the Qualcomm Snapdragon XR2 Gen 2 chip in the headset doesn't compare to an RTX 40-series GPU, it's sufficiently robust.

I also explored some older Quest 2 games that "were enhanced for Quest 3," like rhythm-based shooter *Pistol Whip*, and *Into the Radius*. Both games benefited from the Quest 3's hardware upgrade with notably better graphics, smoother frame rate, and significantly improved draw distances. I'd like to see what other Quest 2 titles will get the enhanced treatment over time. For now, it seems like a handful.

If you're like me, though, most of your VR games reside in your Steam library, so seeing that the Quest Link has returned for the Quest 3 is a welcome relief. Running Steam VR games on the Quest 3 wirelessly is seamless, with most games operating with minimal latency. Your old USB-C link cables should suffice if your Wi-Fi isn't up to par. While Meta offers a new one for $80, more economical third-party alternatives are available.

As a simple VR package, the Quest 3 strikes an excellent balance between performance, comfort, and price. It's a testament that the kitchen sink approach to designing a VR headset isn't always necessary, especially for casual VR gamers. The Meta Quest 3 has yet to sell on the future of mixed reality it's offering, but at least the games look good and play really well. **–JORGE JIMENEZ**

VERDICT
9

Meta Quest 3

+ GALAXY QUEST Easy to set up; Compact; Comfy design; Great display; Affordable.

− THE QUEST FOR PEACE Unproven Mixed Reality content; Expensive accessories; Modest performance upgrades.

$500 (128GB), $650 (512GB), www.meta.com

SPECIFICATIONS

Tracking	Wireless inside-out SLAM tracking
Lens tech	Dual LCD Pancake lens optical stack
Resolution	2064x2208
Refresh Rate	72Hz, 80Hz, 90Hz, 120Hz (experimental)
FOV	110°
IPD	53–75mm
Audio	3.5 mm audio jack
Weight	515g

AVerMedia Live Gamer Ultra 2.1

Get the latest standards in your video capture

THE AVERMEDIA Live Gamer Ultra 2.1 (try quickly saying that three times) is an external capture device that allows you to record HDMI video at 4K resolution and 60 frames per second. So, what's new? The important bit is right there in the name: 2.1. This is the first mainstream capture box on the market to support the HDMI 2.1 standard, but only in passthrough, and without 8K.

The benefit of a capture box like this is that you can pass a 4K, HDR, VRR video stream from a PC (GeForce RTX 3000/AMD RX 6000 or newer) or current-gen console through to a compatible monitor via the HDMI output, as long as every device in the chain is HDMI 2.1 compliant, while capturing a 4K/60 video stream via a USB-C connection to a PC.

It's a niche product, to be sure, but is currently the highest-spec capture box on the market, and the USB 3.2 Gen 2 Type-C connection (you can adapt it to USB-A too, as long as the port is fast enough) gives it broad compatibility across desktops and laptops.

The box itself is rather nicely made, compactly put together, and with a large RGB light bar on the front that can be controlled with AVerMedia's own software, third-party lighting controls, or turned off altogether (which might be the preferred way to leave it, as it may otherwise interfere with streamers' lighting setups). On the back is the USB-C port, which also provides power, the all-important HDMI 2.1 input and output sockets, and 3.5mm jack for headset and controller audio.

The hardware is sound, but boxes like this live and die on their software, and the AVerMedia box is still receiving updates. Ours came with a beta version of the firmware, which became a public release while we were using it, that enabled passthrough of 1440p/240 and 1080p/360 to a monitor on top of the 2160p/144, 1440p/144, and 1080p/240 that were already possible. Extra resolution and framerate combinations, such as ultrawide 3440x1440p/100, should be added in subsequent updates.

IN THE FRAME

The box appears as a source in Obs Studio for capture, and in our testing worked straight away, though RECentral requires an update to use it that should appear in early 2024, and you can configure passthrough settings, including making the HDMI 2.1 signal appear as if it's an older standard for use with incompatible monitors, in the AVerMedia app, as well as fiddle with the RGB.

The big question with a box like this is why you'd want it when there are plenty of cheaper 4K video capture boxes and PCIe cards that can capture 4K without the high price. The reason is the higher framerates used in modern games, especially fast-paced online shooters, in which the amount of movement an enemy can achieve between frame updates can be crucial to whether you actually manage to land a hit or get taken out. You may only be capturing at 60fps, but you're playing at 120 or 240 (or using VRR), and a box like this future-proofs your capture workflow.

You'll need to make sure your monitor and PC graphics card/console are updated to the newest HDMI standard too, but this box provides an essential missing link for using the latest HDMI features (though not 8K) in a streaming situation. It's not going to be for everyone, and its capabilities will slowly become standard across video capture systems, but right now it's the one to go for if you have the need for it. **–IAN EVENDEN**

VERDICT
8

AVerMedia Live Gamer Ultra 2.1

⊞ **VIDE-OH** HDMI 2.1 passthrough; 4K capture; USB connection.

⊟ **VIDE-UGH** No 8K; Expensive; Obs only for now.

$300, www.avermedia.com

SPECIFICATIONS

Interface	USB 3.2 Gen2 Type C
Input and output (passthrough)	HDMI 2.1
Max recording resolution	2160p60
Dimensions	4.72 x 2.76 x 1.09 in
Weight	4oz

The first game was spooky; its sequel is genuinely scary.

SURVIVAL HORROR GAME

Alan Wake 2

A wild barrage of creative storytelling and visual flair

IN THE FIRST PLAYABLE moments of *Alan Wake 2*, you control a nude, balding, middle-aged man stumbling around a forest. After a few seconds of staring at his hairy ass while I guided him around, it dawned on me that this wasn't going to be your typical big-budget videogame.

Even by Remedy's own quirky standards, *Alan Wake 2* is idiosyncratic. You could call it self-indulgent, even, as it dives headfirst into its every strange idea. Weaving a winkingly meta journey through all corners of the studio's lore, at times it feels like watching Remedy get high off its own fumes, which is exactly what makes it so enthrallingly brilliant.

The game picks up 13 years after writer Alan Wake's disappearance at the end of the first game, following both his attempts to escape the mysterious Dark Place—a dimension of psychological nightmare—and the investigations of new protagonist Saga Anderson, an FBI agent sent to the sleepy town of Bright Falls to find the culprits behind a series of ritual murders. You play as both characters, each following their own story threads that parallel and interweave with each other, and you can switch between them at set points, allowing you to experience the two journeys in your own unique order.

Though the story continues almost uninterrupted from the first game, tonally things feel very different in Bright Falls. *Alan Wake* was the sort of game I'd call spooky rather than scary; *Alan Wake 2* is proper survival horror, full of brutal encounters, nail-bitingly tense delves into darkness, and surprisingly gory violence. For both Saga in the real world and Alan in the Dark Place, staying alive means managing your ammo and resources, and carefully deploying sources of light to keep the monstrous Taken at bay and burn away their shadowy defenses.

Remedy's last game, *Control*, was a chaotic power fantasy, every fight a maelstrom of gunfire, superpowers, and any physics objects that dared to exist in your vicinity. By contrast, *Alan Wake 2* is a game of tension and release; long stretches of quiet, building fear, punctuated by short bursts of violence. Impactful, satisfying gunplay helps that structure sing—when you hit a Taken's weak spot, you know about it, as the booming shot rings out, shadows blast out of the wound, and the creature recoils—until it shrugs off having half its torso blasted away and advances on you again.

The first game had a very specific, satisfying rhythm—dodge-torch-shoot-repeat. *Alan Wake 2* has all the same mechanics, but they don't link together so smoothly, preventing the kind of flow state that was possible in its predecessor. The focus is on keeping you on edge, and making you work for your moments of respite. For me, the most frightening enemies in the game ended up being the wolves that lurk in the forest outside Bright Falls. They're not even that monstrous, and they don't take much to put down, but the way they stalk you—circling you in the undergrowth, looking for an opening to leap at you, before retreating out of sight—leads to wonderfully memorable games of cat-and-mouse.

FEAR OF THE DARK

Remedy knows action—they've been making creative, satisfying combat systems since 2001's *Max Payne*. What does show through sometimes, however, is that they're not as experienced with survival horror. The long periods of quiet before a fight breaks out build atmosphere and tension wonderfully, but they give you a lot of opportunity to scavenge, letting you get too well-equipped and leading to too much time spent messing about with your inventory when you'd rather be confronting incomprehensible horrors.

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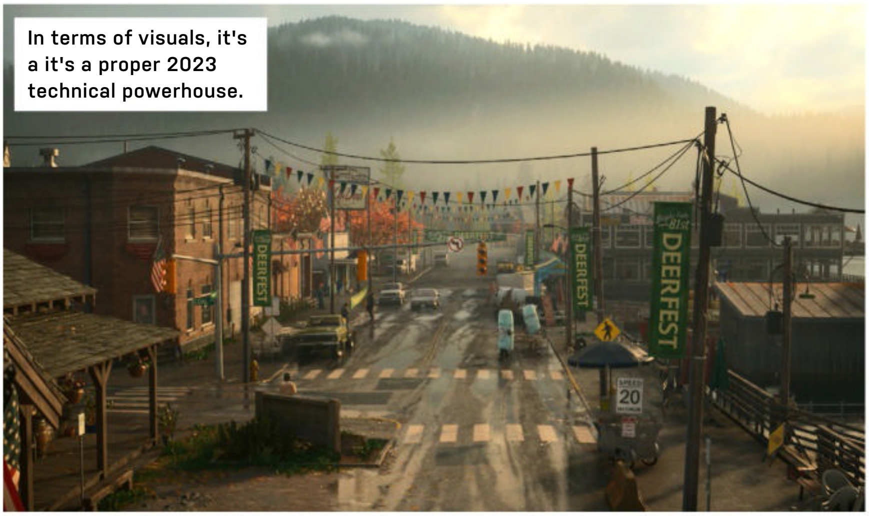
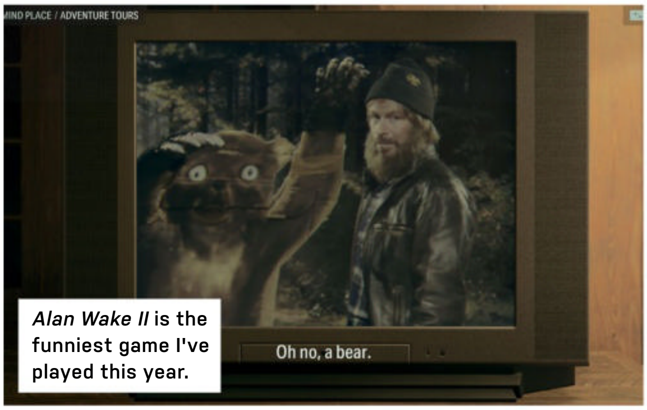
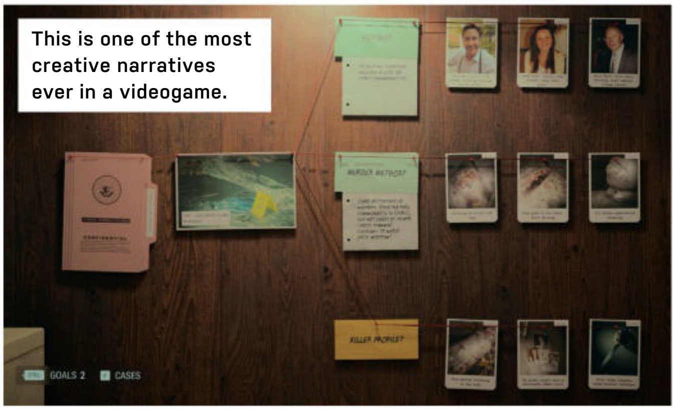


In terms of visuals, it's a it's a proper 2023 technical powerhouse.

FBI agent Saga Anderson is our new protagonist alongside Wake.



Alan Wake II is the funniest game I've played this year.



This is one of the most creative narratives ever in a videogame.

When enemies do arrive, the game often struggles to deploy them in an interesting way. Encounters are exciting, but can feel quite unceremoniously dropped in your path to ensure you have something to do, oddly disconnected from the world around them. Non-boss enemies aren't really introduced or built up, or given a strong connection to the environment—outside of one very disturbing late-game creature, they're mostly the same possessed civilians as in the first game, and can feel a little undercooked compared to the menagerie of horrors in, for example, the recent *Resident Evil* games. Even *Control*'s *Alan Wake*-themed DLC had a more visually exciting take on what the Dark Presence might transform someone into.

But even if the survival horror elements don't always feel fully complete, that's less of an issue than you might think, because really the action is only one part of what's on offer. What Remedy is more preoccupied with in *Alan Wake 2* is its storytelling, and it's one of the most fascinating, strange, and creatively told narratives I've ever experienced.

As in the first game, the horror and madness descending on Bright Falls is driven by an evil force that piggybacks on art and fiction, distorting reality into whatever fits the narrative. It's a wonderful excuse to get absurdly meta, blurring the lines between the story the game is telling you, the story Alan has written, and references to our own world and Remedy's past games. What is the real backstory of Saga and the other new characters, and what has been altered to make them better players in a horror story? Did real events inspire the fiction, or did the fiction retroactively create the real events? Are these real people at all, or completely fictional constructs?

What keeps it on the right side of fun rather than pretentious is how willing Remedy is to punctuate its ideas with a laugh. *Alan Wake 2* is frightening, and at times atmospheric and dramatic, but it's also the funniest game I've played this year. It's brilliant at finding the humor both in over-the-top absurdity—such as a musical sequence that has to be seen to be believed—and the quiet and very personal oddities of a small town.

It doesn't hurt that all of this is presented with such visual craft and flair. Its use of light and shadow isn't as striking as the first game's was back in 2010, but it's a proper 2023 technical powerhouse. The fantastically detailed graphics are impressive throughout—particularly the animation of the characters, whose appearances are so realistic that the game can blend in-engine interactions with live-action sequences near seamlessly.

Alan Wake 2 confirms Remedy as a studio with a truly unique perspective, indulging in all of its wildest ideas and grandest ambitions, and though you couldn't call it focused or restrained, it's a glorious sprawl of surreal horror to explore. It's rare that a game of this scope is allowed to be so completely itself, and the result is an experience that will stay with you long after you've seen every terrifying encounter, cheesy manuscript page, and quirky local TV commercial it has to offer. **–ROBIN VALENTINE**

VERDICT
9

Alan Wake II

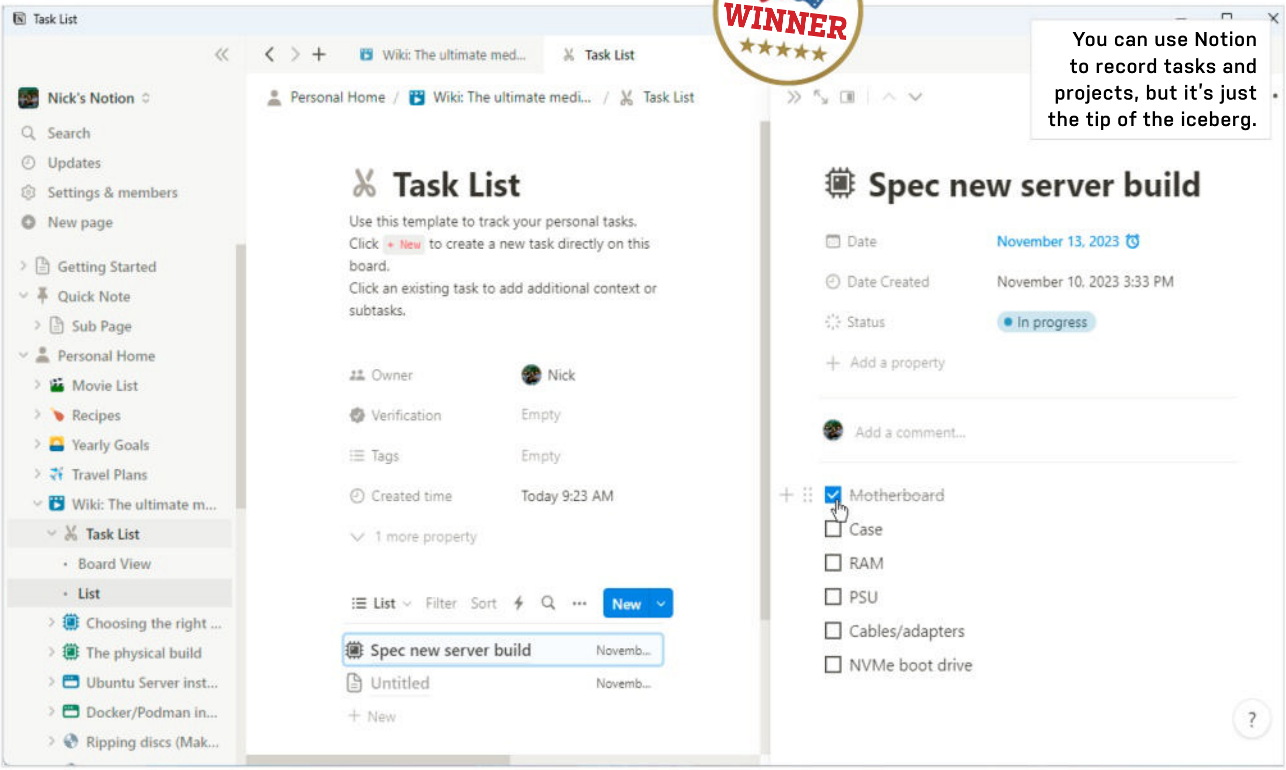
REMEDY Ambitious creative concept; Beautiful visual fidelity; Imaginative mission design.

INJURY Combat lacks variation; Inconsistent performance issues.

RECOMMENDED SPECS CPU, Ryzen 7 3700X / Intel equivalent. GPU, RTX 2060 / Radeon with 8 GB VRAM. RAM, 16GB.

$49.99, www.alanwake.com, M-rated

HEAD TO HEAD WINNER


Task List
Nick's Notion
Search
Updates
Settings & members
New page
Getting Started
Quick Note
Sub Page
Personal Home
Movie List
Recipes
Yearly Goals
Travel Plans
Wiki: The ultimate m...
Task List
Board View
List
Choosing the right ...
The physical build
Ubuntu Server inst...
Docker/Podman in...
Ripping discs (Mak...
Wiki: The ultimate med...
Task List
Personal Home / Wiki: The ultimate medi... / Task List
List
Filter
Sort
New
Add a property
Add a comment...
1 more property

Task List

Use this template to track your personal tasks.
Click + New to create a new task directly on this board.
Click an existing task to add additional context or subtasks.

Owner: Nick
Verification: Empty
Tags: Empty
Created time: Today 9:23 AM

Spec new server build — Novemb...
Untitled — Novemb...
+ New

Spec new server build

Date: November 13, 2023
Date Created: November 10, 2023 3:33 PM
Status: In progress

☑ Motherboard
☐ Case
☐ RAM
☐ PSU
☐ Cables/adapters
☐ NVMe boot drive

You can use Notion to record tasks and projects, but it's just the tip of the iceberg.

Notion vs Todoist

Which is best for staying on top of your projects?

WITH MODERN LIFE refusing to slow down, it's now almost impossible to manage your life on paper, never mind in your own head. Juggling personal and professional projects, all with competing deadlines demanding you give them priority, requires third-party help, and there are a raft of cloud-based services offering to help everyone from individuals to corporations manage themselves better.

We've focused on two services that offer usable free tiers for individuals, and our remit was to see how they fared managing a single person's work and home lives. In one corner is Todoist, a tool with a narrow focus on helping you manage projects through simple to-do lists and deadline-based tasks, while in the other, Notion offers a wider range of productivity tools with project management just one part of a three-pronged approach that also includes space for research (wikis) and notes (documents).

Both tools can be accessed online through your browser, as well as through a variety of desktop and mobile apps. Todoist has the edge in app support, with Linux covered alongside the Apple Watch, as well as offering email plugins to make it possible to convert emails from supported mail clients (including Gmail) into to-do lists, complete with link back to the original email.

If simplicity is your aim, then Todoist is much easier to navigate and quicker to set up. You open to a simple two-pane view, with Inbox, Today, and Upcoming providing you with a range of views. Beneath this are Projects—of which you can manage up to five at a time on the free tier. Projects can be divided into Sections, inside which you can nest your lists.

Todoist keeps things simple by supporting one type of content only: a basic task that comprises a title, optional description, and check box. You can then add a deadline, assign a priority flag, attach labels, and—if you upgrade to a Pro account ($5/mo, $48/year)—set reminders and link the task to a location.

Tasks can be assigned sub-tasks that work in exactly like their parent, and then it's case of choosing where to file them—they can be left unassigned, in which case they'll float about in your inbox, or you can attach them to a single project.

Navigation is quick, and it doesn't take long to grasp pretty much everything Todoist can do. When browsing projects, you have a choice of viewing your tasks as a simple list, or switching to kanban board view, complete with options for both grouping and sorting your items by various criteria, such as date due or priority.

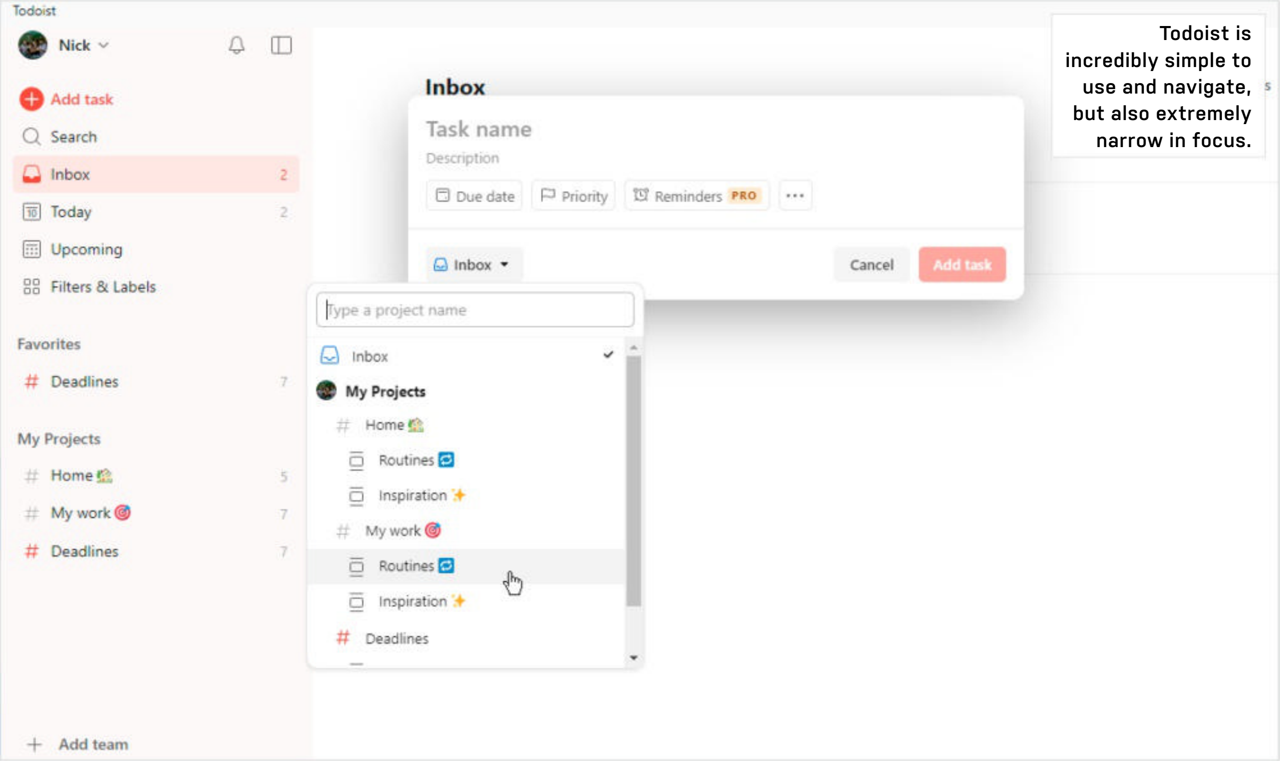
Sharing with others can be done through setting up a link to your cloud-based calendar, while there are options to set up shared workspaces to collaborate in groups, although you're limited to a single workspace on the free tier.

PUSH THE ENVELOPE

Todoist may be simple to use, but it's also quite limited—you can paste hyperlinks into task descriptions, but you can't attach files or notes that may be relevant to your projects. If you want greater control—albeit with a steeper learning curve—then Notion is probably a better bet.

Once signed up, Notion logs you into a two-paned window that'll superficially feels similar to Todoist, but the differences soon mount. Notion organizes all your

© NOTION



Todoist is incredibly simple to use and navigate, but also extremely narrow in focus.

© TODOIST

content into pages, which can contain sub-pages to create an organizational structure. Unlike Todoist's simple task-based lists, however, Notion's pages are far more flexible—they're like Wordpress pages in that they consist of multiple content blocks, of which there are dozens of different types to choose from, including headings, body text, to-do lists, code snippets, file attachments and more.

Pages are easy to put together—simply add a block, choose its type from the dropdown, and then fill it in (and if you're stumped, there's even an AI tool to quickly populate fields for you, although be warned, you'll eventually be asked to pay $10/mo to continue using it after getting an unspecified number of 'complementary responses').

While Notion is perfectly happy to let you start from a blank canvas, it will provide some pre-populated pages for you to see just what can be done—you'll find clever use of structure allied with its flexible content-building blocks results in Notion providing you with everything from simple to-do lists to rival Todoist, to fully blown wikis, journals, and a host of personal-themed pages, like movie watchlists and recipes.

These can be adapted for your own use, but you can also create new pages from templates that span a wide range of content across personal, work, and education sectors, with both your professional (personal finance, career building) and personal (health and fitness) needs covered. There's even a Life Wiki option that attempts to cram everything into one space with a range of pages spanning writing, planning, and personal growth.

It's clear, then, that Notion beats Todoist hands down with the range of content it offers, but it's also the winner within Todoist's specialist field of task-based to-do lists. Notion's task-based pages naturally support due dates and progress labels, but they can also be customized with extra labels and other content. When it comes to viewing your task-based lists, Notion gives you a wider choice of views, with timelines, tables, and galleries additional options alongside the standard lists, kanban boards, and calendars. Better still, you can configure multiple views of a list, switching between them as required via tabs.

We suspect it's already obvious which task-based tool we prefer. If your needs are relatively basic, then Todoist's free tier might be worth exploring to see if its limited toolset can meet your needs, but if you're looking for a one-stop shop to help you go to town on project-based management, then it's clear that you'll need to look elsewhere. Instead, sign up for a free Notion account to discover how its blend of features, flexibility, and user-friendliness can bring order to your chaotic life, and maybe even bring some frustrated ambitions to fruition. **–NICK PEERS**

VERDICT 9 **Notion**

GRAND DESIGN Packed with features; Customizable yet easy to use; Generous free personal tier.

BIG NOTHING Can feel cluttered at times; Navigation sometimes a little convoluted.

AVAILABLE APPS Windows; macOS; Android; iOS, or any web browser.

Free license for individual use; AI-powered features cost $10/mo after set number of uses

VERDICT 6 **Todoist**

PLANNED IN ADVANCE Simple to use; Straightforward navigation; Wide app support

LAST-MINUTE CHAOS Extremely narrow focus; Inflexible and lacking advanced options; Too many core options restricted to paid users

AVAILABLE APPS Windows; macOS; Linux (Ubuntu 20.04+); Android; iOS; Apple Watch, or any web browser.

Free license for individual use; individual Pro account costs $5/mo or $48/yr

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Back Issues
> Meta Questing
> Maintaining an Edge

Is 8GB enough?

I was recently on a long vacation, and I had a chance to make some progress on the *Maximum PC* issues that were waiting in my queue. As such, I have multiple items to discuss.

Answering one letter, you talked about eyeing higher broadband speeds for your home. I wanted to weigh in and tell you not to succumb to the marketing. In my opinion, it is *all* marketing. Case in point, at my lake house in mid Michigan, I have a whopping 25Mb service that actually is closer to 30Mb service. On that service, I have had three of us playing *Diablo 4* while streaming two NFL games on the big screens in HD without any issues whatsoever. There was zero lag, and zero glitching on the games. Now, that doesn't mean I am going to give up my 200Mb service at home, but I am certainly not going to pay a premium for anything faster.

On Nvidia Studio Drivers vs Nvidia Game Drivers, I would love to see a lengthy article on this, especially if there is an easy way to swap back and forth between the two on Win11 Pro. This conundrum applies directly to my wife, Deb, as she works in Photoshop all day (she's a photographer), and plays *Diablo 4* by night. Since *D4* is more of the hobby than the job, should I be installing the Studio Drivers for her? What's the impact, if any, of playing *D4* on high settings with the Studio Drivers? She has an RTX 3060, AMD Ryzen 7 6800H, and 40GB of DDR 5.

In terms of RTX 4060-bashing and 8GB VRAM limit discussions, there have been lots of discussions across multiple issues about the 'upcoming' limitations that the 8GB memory on the RTX 4060 is going to run into. I shopped for almost the entire second quarter of this year looking for the configuration I wanted at a reasonable price, namely the ASUS 15.6" A15 with an RTX 4070 (I absolutely hate the keyboard layout on the Strix 16, so that was a hard pass). The main problem is that at the time, it was only available from 'boutique' shops with a price tag north of $2,000.

I finally pulled the trigger on the same machine with a 4060, 1TB SSD, 16GB DDR5, Ryzen 9 7940 HS for $1,200. I added a 32GB stick of DDR5 for $85, and a 2TB Samsung 990 Pro for $140, and promptly kept about $600 back in my pocket. Considering I was running *D4* on the old 2014 Intel machine with a GeForce GTX 770 (I had to hack the drivers to get *D4* to run), it was a huge upgrade. My question is this: how soon are we going to hit this limitation? Two years? Three years? If so, I'm not stressing about it. I have no issue with running on medium graphic settings down the road, as it still looks pretty damn good on most AAA titles.

Finally, do you pronounce your name Guy as in 'the guy next door' or the French pronunciation Guy like Guy LaFluer (Montreal Canadiens' deceased Hall of Fame hockey player?) I assumed it was the former, but my partner has challenged my assumption.

As always, keep up the good work and pass on to the team the compliments of another satisfied customer. **– B. Maciolek**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: Thanks so much for the detailed email and all of your thoughts on the big topics that were covered in the last few issues of *Maximum PC*!

On to the topic of broadband speeds, you are right, of course—internet service providers will try their best to sell you their top packages that can go way beyond 1Gbps these days, telling you that these speeds are needed for modern homes with lots of users. You would have to be running a lot of 4K streams and/or need to download large games in super-fast times to need that kind of speed. Personally, I have long found 100Mbps more than enough for my needs, but I live in a small apartment with one other person, so obviously I have limited need for speed.

I do get a bit frustrated when I'm eager to play a new game, and the download ends up taking a couple of hours. But for the most part, it's fast enough for most users, even most families, I suspect.

↘ submit your questions to: editor@maximumpc.com

We really do need to do a deep dive on Nvidia's Studio vs Game Ready drivers. I've always understood that performance is broadly the same, as it's the same silicon doing the work, after all. The main difference is that Studio drivers are updated less frequently, because they need to be as stable as possible in order for people to get work done. Game Ready drivers are updated when new games come out, as is hinted in the name, which tends to be around once or twice a month, I'd say, being a user myself. I don't know if your partner takes a hit in *Diablo 4* for using Studio drivers, but we should find out—someone get our GPU specialist Jarred Walton on the phone!

On the 8GB VRAM question, the current list of titles that can use more than 8GB of memory is about 17 or so games. Note that 'can', not 'need'—you can still play when you have less memory, but you can't take advantage of the higher resolutions and settings without having 12GB or more. The games list isn't an obscure one—it's big titles that many PC gamers would want to play at their best, like *Dead Space Remake*, *The Callisto Protocol*, and *Forspoken* (the latter maxing out at 13.1GB of VRAM). I personally wouldn't worry too much about it—if you find yourself wanting to play games at maximum settings then you're more likely to buy a top-end GPU, which come with lots more VRAM, and therefore there won't be any problem for you.

As for my name, it's pronounced "Gai", as in 'guy next door'. I don't have any French heritage, I'm afraid, although I do sometimes prefer the way they pronounce the name!

Virtual insanity

I'm using the Meta Quest 3 VR headset, and I want to have a good gaming PC to support the Quest Link option. My current PC is a Dell Inspiron 5675 with an AMD Ryzen 7 1700 Processor, 16GB RAM, and Windows 10 64-bit. Apparently, I cannot upgrade to Win11 with my current hardware.

I feel like my computer is not up to the video quality in VR that I would expect from it. I've had to work with the Meta Quest support team to get it to connect and have had some success. My question is, would I notice a difference with new upgraded computer? Or should I just try and upgrade my current system?

PS. I really enjoyed your recent articles about graphics cards.

– G. LeCureux

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: This feels like it could be a question to pass on to our resident Doctor, but I'll take a guess at the Win11 upgrade issue—it's most likely to be an issue with your system not supporting Trusted Platform Module (TPM) or another security-based issue. Your CPU is about six years old now, so it's not what we'd call ancient, but all the same, it's possibly not up to the security standards that Microsoft demands in order to run its latest O/S.

You can rest assured that this is okay though, because in order to run VR games—even ones with relatively low graphical demands—I would encourage you to upgrade your hardware anyway.

You don't mention which GPU you're using in the Dell, but it's probably also the same age as your CPU (if, indeed, you have one), and that's not going to cut it when it comes to running modern VR games that demand a high refresh rate in order to keep things as smooth as possible.

Ultimately, it all depends on what sort of games you want to play—if it's something along the lines of *Fruit Ninja* or *Beat Saber*, then you don't need anything too beefy, but for games like *Half-Life: Alyx*, you will almost certainly want something a bit better. Even then though, a mid or even low-end card will be sufficient, as the minimum GPU is only a GTX 1060/RX 580. Enjoy your VR gaming!

Frame rate booster

Long-time listener, first time caller, as they say! I'm sure I'm not the only one who is looking to improve PC performance for latency-sensitive games (in the FPS genre). I have a PC based on the AM4 platform. I'm running around 150-200 FPS in PUBG in low settings. I've upgraded my RAM to 4,600MHz, including OC. The chip is the Ryzen 6950x, in a B550 motherboard paired with 6800XT GPU.

I've noticed small things can make a big difference, like a keyboard with adjustable sensitivity. I've also become aware that the pros are running at 300+ FPS. My question is how should I think about measuring performance? I find human benchmarking quite interesting—I'm around 180-190ms response time for the click reaction time test. Is it just FPS? And what I should be doing to upgrade—I'm not sure what will move the needle, aside from an entirely new build. I think at these higher FPS levels you are more likely to be CPU-bound.

Thank you!

– T. Olszewski

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS: The one thing that you haven't mentioned in your letter is what monitor you're running—presumably it's over 240Hz, so that you're getting the benefit from those high *PUBG* frame rates. If you want a competitive edge when playing various eSports titles, then we would probably recommend that as the place to start—first, make sure that you have a monitor that has a high refresh rate and low latency. You could go for a 1080p one if all you're playing is these fast-paced titles, but we still think that the sweet spot is 1440p, which your fairly new GPU is positioned to support, too.

I know that you have an AMD card, but I've used Nvidia's Reflex mode when attending CES earlier this year, and was impressed with the impact that it had on FPS response time, almost immediately giving me a substantially better kill ratio in *Overwatch 2*. I've not used Radeon Anti-Lag feature, which is AMD's equivalent, but it might be an idea to investigate it in the Adrenaline software to see if it helps make you more competitive.

One thing that Zak and I discuss in this month's story of the build is how tunable the latest 14th gen Intel chips are when it comes to DDR5 RAM, which would require an upgrade to your current system. Zak was saying how overclocking your RAM can really help when it comes to these sorts of games, so naturally, streamers and eSports players are all over them. But that will require a complete overhaul of your system. I hope this helps you out with your questions!

THE BUILDS

THIS MONTH'S STREET PRICES...

BUDGET

THE TERM 'BUDGET' USED IN THIS SENSE is to depict our lowest value build, yet all of our blueprint builds have a so-called budget. Thankfully for us, this is virtual, and we can play around with said so-called budget as much as we like. What happens next is a balanced selection of equivalent components to fit each build, and this lower-tier machine is the most money-conscious of the bunch. Despite this, it still offers modern parts, with good performance and plenty of room for upgrades down the line.

Starting with the Intel budget machine, we are making a change to our power supply (also found on the AMD budget build). The EVGA PSU has gone back up to $90, so we are switching to the Thermaltake Toughpower GX2, a 600W 80+ Gold PSU with plenty of power for this level of PC, coming in at a lower $59.

The main captain of the ship, the Core i5-12400F, has dropped by $10, and its newly added right-hand man, the Zotac GeForce RTX 4060 Ti GPU, has remained at the same price. However, what it is seated on has changed. We are getting rid of the former Micro-ATX motherboard for a larger, more compatible board, the ASRock Z690 Phantom Gaming 4/D5. At $119, it's worth the extra $20 to bring more futureproofing to our machine.

We had to swap our DDR4 RAM for some TEAMGROUP T-Force Vulcan DDR5 sticks. These are faster, running at 5200MHz—the PNY XLR8 Gaming EPIC-X RGB sticks had speeds of up to 3600MHz. Other than that, the Intel build stayed the same.

Sailing over to destination AMD, as we mentioned before, this receives the same PSU treatment as the Intel machine. We brought in the Sapphire Pulse AMD Radeon RX 6700 XT 12GB last issue to boost the overall gaming appeal of this machine and bring it up a notch from the previous GPU. However, with no price changes on this or any other component, we are happy with how this AMD machine is sitting, so are not making any changes.

AMD INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	600W Thermaltake Toughpower GX2 80+ Gold **NEW**	$59
Mobo	MSI B550M PRO-VDH WIFI Micro ATX AM4 Motherboard	$105
CPU	AMD Ryzen 5 5600	$134
GPU	Sapphire Pulse AMD Radeon RX 6700 XT 12GB	$309
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB DDR4 @ 3600MHz	$45
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD	$85
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$914**

INTEL INGREDIENTS

PART		PRICE
Case	Corsair 4000D Airflow	$95
PSU	600W Thermaltake Toughpower GX2 80+ Gold **NEW**	$59
Mobo	ASRock Z690 Phantom Gaming 4/D5 ATX LGA1700 **NEW**	$120
CPU	Intel Core i5-12400F	$140
GPU	Zotac GAMING Twin Edge OC GeForce RTX 4060 Ti 8GB	$370
RAM	16GB (2 x 8GB) TEAMGROUP T-Force Vulcan DDR5 @ 5200MHz **NEW**	$63
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD	$85
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,014**

MID-RANGE

FROM SOLID 1080P GAMING, we now leap upwards to QHD territory with our mid-range builds. Here, we have a larger virtual pit of money to amp up the overall performance of our PCs. As with most custom PCs, choosing the GPU can be the most time-intensive part of the journey—finding one at the right price and then often building the rest of the machine around it. We did feature a Radeon RX 7800XT in this section not so long ago thanks to a bit of a crazy sale, but last issue we had to say goodbye and bring in a cheaper RX 6800 to fill the space. With no price alterations since then, the XFX SPEEDSTER SWFT 319 Radeon RX 6800 is still our GPU of choice for the AMD mid-range.

The brains for the AMD system also remain the same—taking the hot seat is the AMD Ryzen 5 7600X. It's a competent and powerful CPU for gaming and productivity-based tasks, especially for the price. One thing we wanted to do was replace the Micro-ATX board, just like we did for the Intel budget PC, swapping the ASRock B650M PG RIPTIDE Wi-Fi Micro ATX for the MSI B650 GAMING PLUS WIFI ATX. This will bring more room for fans, additional storage, and improved longevity.

The prices for GPUs on the Nvidia side have been dropping slightly more than the Radeon lineup. As we are using the Nvidia range for our Intel systems, this certainly is a pleasant sight. You can now get an RTX 4070 for just over $500, so it's on its way down to below $500. We have the Zotac Twin Edge RTX 4070, which we introduced last issue, as this is one of the cheapest at $520. It received a $10 deduction from last time.

The only change on the Intel mid-range build was another motherboard swap—a marginal upgrade to the ASRock Z790 PRO RS WIFI. It's a more visually interesting board than the previous Gigabyte Z790 UD AC ATX. The latter certainly had a cheaper look to it, and for an extra $10, the swap was worth it.

AMD INGREDIENTS

PART		PRICE
Case	NZXT H7 Flow	$130
PSU	750W EVGA 750 BP 80+ Bronze	$90
Mobo	MSI B650 GAMING PLUS Wi-Fi ATX AM5 **NEW**	$180
CPU	AMD Ryzen 5 7600X	$240
Cooler	MSI MAG CORELIQUID 240R V2	$88
GPU	XFX SPEEDSTER SWFT 319 Radeon RX 6800	$399
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	$98
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD	$85
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,392**

INTEL INGREDIENTS

PART		PRICE
Case	NZXT H7 Flow	$130
PSU	750W EVGA 750 BP 80+ Bronze	$90
Mobo	ASRock Z790 PRO RS WIFI ATX LGA 1700 **NEW**	$190
CPU	Intel Core i5-13600K	$307
Cooler	MSI MAG CORELIQUID 240R V2	$88
GPU	ZOTAC GAMING RTX 4070 Twin Edge DLSS 3 12GB	$520
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 CL40 @ 4800MHz	$98
SSD	1TB Lexar NM790 PCIe 4.0 M.2 SSD	$85
HDD	2TB Seagate Barracuda Compute 7200	$50
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$1,590**

TURBO

OUR TURBO MACHINES don't tend to see as many alterations or sales as the other two tiers in our blueprints section. This is generally due to us reaching a certain performance point and waiting for greater components to come out. Sales are rare, as these are much more sought-after components. This time though, we do see a fair few changes to our top-end rigs.

Something that helps bring on price reductions is the release of new generations. Speaking of, we can now bring in Intel's latest flagship 14th-gen i9 chip, the i9-14900K. Although this is the latest and technically the greatest from Intel, it shouldn't discredit the i9-13900K or KF variant it supersedes, as they are still speedy chips. Regardless, it's an improvement.

This chip is paired with the RTX 4090, still the best GPU on the market, but unfortunately, its value has risen above $1,500. Our previously chosen Zotac GeForce RTX 4090 GAMING Trinity OC has spiked to $1,900. Now, we can meet its replacement, the PNY XLR8 Gaming VERTO EPIC-X RGB OC. This is $1,670, which is still overpriced, but one of the cheapest, relatively speaking.

Both of these Intel turbo build changes will be sitting on a fresh new motherboard, Gigabyte's Z790 AORUS ELITE AX. A premium build needs a premium motherboard—the previous Gigabyte Z790 UD AC ATX didn't quite live up to those standards, so we saw it as time to make the change. Hopefully, we will see some price changes for the RTX 4090 GPU, but for now, we are happy with our top offering on team Intel.

On the AMD powerhouse rig, things aren't as exciting. We are keeping our motherboard, as it's still very relevant and premium. Also, the pairing of the AMD Ryzen 9 7950X3D and AMD Radeon RX 7900 XTX is still our selected lineup. We've saved $20 on the processor from the last issue, and have kept the SAPPHIRE PULSE Radeon RX 7900 XTX 24GB. This is still one of the cheapest RX 7900XTX cards, but it's gone back up to $950. We also saved $30 each on our Phanteks Enthoo Pro 2 cases for both builds. That somewhat softens the blow, but still, we hope to see GPU prices fall again over the next month or so.

AMD INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$160
PSU	1000W NZXT C1000 80+ Gold	$180
Mobo	ASRock X670E PG Lightning ATX AM5	$250
CPU	AMD Ryzen 9 7950X3D	$630
Cooler	NZXT Kraken X73 RGB 360mm	$295
GPU	SAPPHIRE PULSE Radeon RX 7900 XTX 24GB	$950
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$165
SSD	2TB WD Black SN850X M.2 PCIe 4.0	$80
HDD	6TB WD Blue 5400 HDD	$100
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,842**

INTEL INGREDIENTS

PART		PRICE
Case	Phanteks Enthoo Pro 2 Tempered Glass	$160
PSU	1000W Corsair RM1000x Shift 80+ Gold	$210
Mobo	Gigabyte Z790 AORUS ELITE AX ATX LGA1700 **NEW**	$250
CPU	Intel Core i9-14900K **NEW**	$592
Cooler	NZXT Kraken X73 RGB 360mm	$295
GPU	PNY XLR8 Gaming VERTO EPIC-X RGB OC 24GB **NEW**	$1,670
RAM	64GB (2x 32GB) Corsair Vengeance DDR5 CL40 @ 5200MHz	$165
SSD	2TB WD Black SN850X M.2 PCIe 4.0	$80
HDD	6TB WD Blue 5400 HDD	$100
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$3,554**

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